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Vol. II - [illegible]

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HORTICULTURAL BUILDING AND GREEN HOUSE.
(Constructed During 1898-99.)

To His Excellency, Lloyd Lowndes,

Governor, and President of the Board of Trustees,

Annapolis, Md.

Sir:

In accordance with the provisions of Section No. 3, of the Act of Congress, approved March 2nd, 1887, "To Establish Agricultural Experiment Stations, Etc.," I have the honor to transmit the Twelfth Annual Report of the Maryland Agricultural Experiment Station for the fiscal year ending June 30th, 1899.

Very Respectfully Yours,

H. J. PATTERSON,

Director of the Experiment Station.

Transmitted October, 1899.

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THE MARYLAND
AGRICULTURAL EXPERIMENT STATION

VOLUME No. 12. 1898-1899.

—THE—
Twelfth Annual Report

For the Fiscal Year, July 1st, 1898, to June 30th, 1899.

This report is confined to the completed work and the financial statement of the Station for the fiscal year ending June 30, 1899. The completed work of the year is contained in six bulletins which have been published, a list of which and the full text of each appears in succeeding pages of this report. It has been deemed best to make up the annual report in this manner rather than to follow the custom during past years of publishing detailed statements and reviews by each officer, as these incurred considerable expense, and were of no material interest to any one.

Questions of practical importance, both for immediate and future application to the various agricultural interests of this State, have received the attention of the Station workers, and been pushed vigorously forward, some evidence of which is manifested in the bulletins published.

As time passes on the Station's facilities for work become more complete. The land is brought into a more satisfactory condition. Buildings are added and remodeled, appliances are increased and the equipment generally improved.

Thus far we have been able each year to expend less time and money upon preparation and more for labor and current expenses of experimentation than the year before. But the time has come, with our fixed income, that it is impossible to materially increase the quantity or the variety of the work. In fact, under present conditions it is a question if it would not be a better policy for the Station to reduce the number of lines and variety of work and to concentrate its efforts upon a few of the most important interests, and to depend upon other Stations for information which is of general application.

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Buildings and Equipment.—The facilities for work in horticulture has been materially increased by the erection of an office building for that division, and contiguous thereto a green house and propagation house. These houses are divided into compartments to afford opportunity for varying heats and humidities, and are also provided with solid and bench beds and facilities for sub-irrigation. The heating is done by a hot-water plant placed in the cellar of the office building. A picture of this building forms the frontispiece of this report. The interior of the main Station barn has been slightly remodeled so as to better facilitate work. The offices and library in the main building have been rearranged so as to give one room devoted to the mailing and storage of bulletins. The largest room in the house is now used for a library, and by dividing it into alcoves gives opportunity for classifying the books and space for growth. Considerable money has been spent on apparatus and equipment for the Plant Pathological, Veterinary, Entomological and Dairy Bacteriological divisions.

Mailing List.—Owing to the great number of changes of address, etc., which has occurred in the eleven years of the Station's existence, and also from the desire to procure lists of farmers interested in special subjects, it was deemed advisable to revise the Station Mailing List. For this purpose a self-addressed private postal card was sent out to each person on the old Mailing List asking for the desired information and their name and address if the bulletins were wished in the future. Most of these cards have come back properly filled up, but there are still some who have failed to return them. Persons who have not responded will be given another opportunity before their names are stricken from the list. It is to be regretted that more farmers do not avail themselves of the opportunity to get information on various agricultural subjects through the free bulletins which the Station issues, and which any one may have by simply asking for them. At the present time bulletins are sent to about 7,000 farmers in Maryland, but there should be a bulletin go to each of the 40,000 farms in the State.

The Station Staff.—The working force of the Station was increased during the year by the addition of Prof. C. O. Townsend, Ph. D., as Plant Pathologist, and Guy L. Stewart, B. S., Assistant Pathologist, which was necessitated and provided for by the new law for the suppression of insect pests and plant diseases. Chas. F. Doane, B. S., was appointed assistant in Dairy and Bacteriology, and started in upon his work in October, 1898. C. W. Dorsey, Assistant in Soil Physics, resigned January 1st, and his place was not permanently filled during the year.

Farmers' Meetings and Exhibitions.—The policy has been continued of the Station officers participating as often as possible in Farmers' Institutes and other appropriate farmers' meetings held in different parts of the State. This class of work not only affords a good opportunity to acquaint the people with the work of this Institution, but also is the means of acquiring much information which is very useful in planning and prosecuting various lines of investigation. In past years considerable has been done in the way of attending and making exhibits at agricultural fairs and other exhibitions. These exhibits give the people object lessons of the results of experiments, and will call it to the attention and impress it upon many people that could not be reached by the press or bulletin. It is hoped that funds of the Station will permit the resumption of some work in this direction, as it would be very beneficial to all interests.

Visitors and Correspondence.—These two methods of intercourse with those who are interested in the work of the Station are encouraged as much as possible, and both are increasing yearly. No opportunity is lost to make it known that visitors, singly or in parties, with or without previous notice, are always welcome, and that every effort will be made to make such visits pleasant and instructive. Those who cannot come are encouraged to write, suggesting and inquiring, and the Station officers give such letters every possible attention. This correspondence now constitutes a large part of the office work, and embraces a great variety of subjects connected with agriculture and horticulture.

Weather Report and Financial Statement.—Appended herewith is given the Meteorological Summary for 1898 and the Financial Report of the Treasurer for the fiscal year ending June 30th, 1899.

Meteorological Summary For 1898.

TEMPERATURES IN DEGREES.

(FAHRENHEIT.)

MONTH.	PRECIPITATION.	Temperature—Mean.				Extreme Maximum.	Extreme Minimum.
		Daily Mean.	Maximum.	Minimum.	Daily Range.	Record and Date.	Record and Date.
January	In. 3.84	37.9	48.5	32.5	11.0	61—8th-13th.	16—4th.
February....	1.36	36.3	45.2	27.3	17.9	68—11th-12th.	11—4th.
March.	2.23	49.2	57.8	40.9	16.9	73—17th.	25—26th.
April.......	2.24	51.3	60.8	42.4	17.4	79—23d.	28—26th
May.........	3.48	64.6	75.0	55.1	19.9	92—20th.	35—9th.
June........	0.85	77.2	87.2	60.8	26.4	97—28th.	48—22nd-23d.
July.........	2.11	21.2	89.6	69.1	20.5	105—2d.	48—11th.
August......	6.08	77.1	8.70	67.5	19.5	86—3d-31st.	54—28th.
September..	0.56	68 5	81.5	59.0	22.5	98—3d.	41—12th.
October......	3.33	58.0	68.6	48 0	20.6	84—4th 11th.	27—28th.
November...	3.88	25.4	54.0	36.1	17.9	69—9th.	28—25th.
December...	5.78	35.0	44.4	26.7	17.7	61- 3d.	4—15th.
Yearly.......	35 24	50.2	66.2	47.1	25.6	105—July.	4—Dec.

FINANCIAL REPORT, 1898-1899.

Jos. R. Owens, Treasurer, in account with the Maryland Agricultural Experiment Station.

1898.	Source of Revenue.	Dr.
July 1, To	unexpended balance	$522.89
" "	U. S. appropriation	15,000.00
" "	sale of produce	1,856.07
		$17,378.96

1899.	Nature of Expenditure.	Cr.
June 30th, by	Salaries	$6,636.58
" " "	Labor	3,114.86
" " "	Publications	699.79
" " "	Postage and Stationery	152.53
" " "	Freight and Express	171.79
" " "	Heat, Light and Water	300.17
" " "	Chemicals	70.14
" " "	Seeds, Plants and Sundry Supplies	600.60
" " "	Fertilizers	101.31
" " "	Feeding Stuffs	1,039,12
" " "	Library	595.59
" " "	Tools, Implements and Machinery	832.05
" " "	Furniture and Fixtures	214.69
" " "	Scientific Apparatus	573.27
" " "	Live Stock	130.00
" " "	Traveling Expenses	137.95
" " "	Contingent Expenses	135.00
" " "	Buildings and Repairs	1,807.48
" " "	Unexpended Balance	5.69
		$17,378.96

The undersigned duly appointed Auditor for the corporation, do hereby certify that I have examined the books and accounts of the Maryland Agricultural Experiment Station for the fiscal year ended June 30th, 1899; that I have found the same well kept and classified as above, and that the receipts for the year are there shown to have been $17,378.96, and the corresponding disbursements to have been $17,373.27. Vouchers for the expenditure of all of this have been examined by me and found correct, thus leaving an unexpeneded balance of $5.69, to be accounted for by the Treasurer in the fiscal year commencing July 1st, 1899.

FRANK BLACKLOCK,
Auditor.

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PROF. C. V. RILEY.

THE MARYLAND

AGRICULTURAL EXPERIMENT STATION

BULLETIN No. 57. AUGUST, 1898.

Report on the San Jose Scale in Maryland, and Remedies for its Suppression and Control.

By Willis G. Johnson, A. M., Entomologist.

INTRODUCTORY.

It was the intention of the writer to have embodied this report in a more exhaustive one, including all the work of this department for the years 1896 and 1897, but the lack of funds precluded its publication. This report, therefore, in its present form, is published exclusively out of the funds of the State Horticultural Department, and embraces my observations and experimental operations as State Entomologist and Entomologist of the Agricultural Experiment Station.

I wish to acknowledge here my grateful appreciation of the encouragement and hearty cooperation I have always received from President R. W. Silvester, of the Agricultural College, in the development of my department and the prosecution of my work. I am also under many obligations to Mr. Franklin Sherman, Jr., who voluntarily assisted me from July, 1896, to April, 1897. My thanks are also due to Mr. Robt. H. Miller, former director of the station, and especially, to Mr. Robert S. Emory, who has so materially assisted me in my experimental work. I have also been shown many favors by Dr. L. O. Howard, the United States Entomologist, for which I am very grateful. Mr. E. Dwight Sanderson, my assistant, has also rendered much valuable service. I am also indebted to the fruit growers and nurserymen who have ever been ready to assist me and cooperate with me along any line of experimental work. I desire also to thank Mrs. C. V. Riley for the excellent photograph of her late husband, which is herewith reproduced.

The author regrets exceedingly that he cannot give, at this time, all the experimental work that has been completed, and is now ready for publication. The results, however, will be given to the general public as rapidly as possible, in this series of bulletins, of which this is the second, published in accordance with the Laws of Maryland 1898, Chapter 289.

PROF. C. V. RILEY.

It is a pleasure for me to preface my report with a short sketch of my predecessor as station entomologist, the late Professor C. V. Riley. The frontispiece shows him in his characteristic position at work, and is reproduced for the first time from one of his latest photographs, taken in 1893, about the time he became officially connected with the Maryland Agricultural Experiment Station.

In June, 1893, Prof. Riley was elected Entomologist and Physiologist of the Station a position he occupied up to the time of his death. During his connection with the station he attended to the correspondence of his department and published two bulletins. The first, (Bul. No. 23) appeared in December, 1893, and was a popular account of some injurious species, the first of a series which he intended to have issued upon the insects of Maryland. The second, (Bul. No. 32) was issued in April, 1895, and embodied an account of the San Jose scale in this state. It was his intention to have added to the station cabinet a set of the insects he had in duplicate in his collections. This collection had been started, and eight cases of beetles and two of butterflies had been transferred to the station before his death occurred.

As an officer of the station, and for the entomology of Maryland, Professer Riley had planned to prosecute some original research and investigate many unsolved problems of economic importance; but all was cut short by his untimely end.

The circumstances which occasioned the death of Professor Riley are very sad. September 14th, 1895, shortly after nine o'clock, he mounted his bicycle, and in company with his son, started from his residence on Wyoming Avenue in Washington, D. C., for the central part of the city. Before reaching Connecticut Avenue, a short distance away, he was accustomed to going down a rather steep hill, and on this occasion those who saw him noticed that he was riding more rapidly than usual. At the intersection of Connecticut avenue and S street the front wheel of his bicycle struck a piece of granite lying on the concrete, and, turning suddenly at right angles, Professor Riley was thrown with great force, head downward on the pavement. His apparently lifeless body was picked up and laid on the parking, and in a few minutes several physicians were present. Everything possible was done for the unfortunate man, but to no avail. He died shortly after midnight September 15.

The following biographical sketch is too brief for us to do homage to the man who, pre-eminent above all others, has done so much to place economic entomology upon a footing with other allied sciences; but space will not permit me to say more in this place.

Charles Valentine Riley was born in London, September 18, 1843. He spent his early boyhood days in the village of Walton, on the Thames, and at an early age exhibited a fondness for collecting, and took a keen interest in painting and drawing. When ten years of age he began collecting notes and making drawings of the insects in his neighborhood, with a view, as he said, of describing the transformations of all the species in that vicinity. Dr. L. O. Howard, the present United States

Entomologist, who has seen these early drawings, says they "indicate a most unusual artistic talent."

By the death of his father, who was a clergyman of the Church of England, young Riley soon developed a self-reliance and sense of responsibility that characterized him later in life. When eleven years of age he was sent to boarding school in France, and later to Germany. His familiarity with these languages was of invaluable service to him in his professional life, as he spoke both with exceptional accuracy.

It appears that his views were not at all in accord with those who had encouraged him to take a classical education, as we find him, at the age of seventeen, setting sail for New York, where he arrived after a seven weeks' voyage with little means and "a stranger in a strange land." That young Riley was of a practical turn of mind was again exhibited after his arrival here from the fact that he settled upon a farm in Illinois where he remained for four years until he had acquired an experience of practical agriculture. He then went to Chicago, where he took up journalistic work, drawing portraits, and at the same time paying special attention to botany and entomology. Finally he became associated with the *Prairie Farmer*, and his writings on economic entomology were enthusiastically received by the general public. As an attache of this agricultural newspaper he attended farmers' and fruit-growers' meetings, and soon had a large number of friends and acquaintances. It was at the meetings of the Illinois Horticultural Society that he subsequently became acquainted with Benjamin D. Walsh, a man of remarkable character and unusual ability, of English university education, who was in 1867 appointed the first State Entomologist of Illinois. They became close friends, and Walsh exercised a great influence upon Riley's future. They founded and edited the *American Entomologist*, and it was mainly through the influence of Walsh that Riley was chosen State Entomologist of Missouri, when the law was passed for the creation of that office in 1868.

He was now twenty-five years of age, and he shouldered the responsibilities of his new office with great energy and enthusiasm. The golden opportunity of his life had now come, and before he had completed the last of his now famous nine Missouri Reports, he was recognized, not only in this country, but in all parts of the civilized world, as the foremost living economic entomologist.

These reports are based almost entirely upon original observations, and are replete with original drawings of life-like characters of marvelous scientific accuracy. This remarkable work was accomplished single-handed, and in a field that was distinctly his own. It has been called epoch-making in its character, and any one reviewing this pioneer work must admit that it is the product of a master—a most extraordinary man.

Through his efforts the United States Entomological Commission was established by Congress in 1876, and his services in connection with this commission as its Chief were of great value to the general agricultural public. He accepted the position of Entomologist to the Department of Agriculture in 1878, but gave up the place shortly afterward, retaining, however, his connection with the Entomological Commission, and continued his work for the government.

When the Division of Entomology of the Department of Agriculture was created in 1881 Professor Riley was placed at its head, a position which he held continuously until the time of his resignation, in 1894, on account of impaired health. His influence in the Department of Agriculture was very great, and he was the prime mover of many important reforms.

He was a member of many scientific and agricultural societies in this country, and always took an active part at the meetings of the Society for the Promotion of Agricultural Science from the time he joined it in 1882. He was also an honorary member of many foreign societies.

After his resignation from the Department of Agriculture in 1894 it was his intention to have devoted himself solely to pure scientific research. In 1896 he gave his collections of insects, comprising about 20,000 species, which represented over 115,000 pinned specimens and other material, to the United States National Museum, Department of Insects, of which he was Honorary Curator. Had Riley lived, no doubt the greatest work of his life would have been produced in his later publications.

REVIEW OF THE ENTOMOLOGICAL FEATURES OF 1896.

Immediately after assuming charge of the Entomological work of this State on July 1st, 1896, I began an inspection of the orchards and nurseries in accordance with the provisions of the Trees and Nursery Stock Law, Chapter 290, Laws of Maryland, 1896. I found very soon that the San Jose scale was very widely distributed throughout the State, and that considerable damage had been done to bearing orchards in several counties. This work is reported in detail at another place in this report.

Next to the San Jose scale, the melon plant louse, *Aphis gossypii*, caused more damage in our State than any other insect the season of 1896. Hundreds of acres of canteloupes were destroyed by it in Baltimore, Anne Arundel, Prince George, Charles, Calvert, St. Mary's, Wicomico, Dorchester and Somerset Counties the latter part of June and early in July. After making a number of preliminary tests, we found that under spraying of the leaves with kerosene emulsion, diluted with 20 parts of water, was the most convenient method of treatment.

Anticipating a repetition of this outbreak in 1897, I prepared and published Bulletin No. 48, of this Station, in which I gave an account of the habits and life history of the melon plant louse, together with suggestions and remedies for its destruction and control. This bulletin also contained an account of several other injurious species of plant lice which are common in this state.

The asparagus beetle, *Crioceris asparagi*, was exceedingly abundant and destructive over a large part of the state. I saw large numbers of larvae on asparagus in Kent, Dorchester, Montgomery and Washington Counties during the month of August. The 12-spotted species, *C. 12-punctata*, was also quite common throughout these counties, but not nearly so abundant as the foregoing. The spotted species, however, seem to be increasing to a considerable extent, especially in the counties where asparagus is grown over large areas. I am of the opinion that it will become as serious a pest as the old species in the near future.

The potato stock weevil, *Trichobaris trinotata*, did considerable mischief to potatoes in Baltimore and Howard Counties. August 10th I inspected potato fields in the vicinity of Greenwood, Baltimore County, at the solicitation of J. G. McComis, and found that nine-tenths of the vines had been killed by this insect. Nearly every stem contained one or more larva or pupa. Later observations throughout other parts of the state, especially in lower Washington and upper Montgomery Counties, I found that the same insect was doing considerable damage.

The Colorado potato beetle, *Doryphora 10-lineata*, and the blister beetle, *Epicauta cinerea*, also did great damage over a large portion of the state.

Cabbage especially, suffered severely from the attacks of the cabbage worm, *Pieris rapae*, the cabbage Plusia, *Plusia brassicae*, and the Harlequin cabbage bug, *Murgantia histrionica*, over the entire State. This latter insect being of considerable importance and gaining in numbers over the state. We will give a detailed account of it, with illustrations of its various stages in a bulletin to be published this fall.

The strawberry weevil, *Anthonomus signatus*, appeared in great abundance the early part of the season, and was especially injurious to certain early varieties. The greatest damage was done in Anne Arundel, Baltimore, Caroline and Somerset Counties.

The plum curculio, *Conotrachelus nenuphar*, concentrated its attacks upon peach, and did great damage to pear in the tide-water section of this state. much of the former fruit ripening prematurely and falling from the trees.

The codling moth, *Carpocapsa pomonella*, was especially conspicuous in the apple-growing sections of the state, and did considerable damage.

The imported elm leaf beetle, *Galerucella luteola*, was very abundant on English elms throughout the state. and many trees were completely defoliated by the larvae of the first brood. The most serious effect was noted, however, later in the season, as the second brood were reaching maturity.

Another insect which is making considerable headway in this state as a shade tree defoliator, is known as the locust leaf beetle, *Odontota dorsalis.* I saw the ravages of this pest in all the lower Counties of the state, especially those bordering the water ways. In many instances the trees scattered over large areas had their leaves completely seared and were as brown as if they had been burned.

In September I found the army worm. *Leucania unipuncta*, very abundant near Berlin, Worcester County. In some fields, corn had been stripped of its blades, nothing being left except the mid-rib. Millet had also been injured to a considerable extent. September 17th, the worms were abundant in corn shocks that had been recently cut on the farm of R. C. Peters. I also noted the ravages of the insect in Washington County above Hagerstown, near Chewsville, September 12th. The principal damage was done to millet, although grass and corn were injured to some extent. September 10th, Randolph Humphreys, of Salisbury, Wicomico County, sent specimens of this insect to the College for examination. He stated that the pest was doing much damage in his County.

The Hessian fly, *Cecidomyia destructor*, was not uncommon in Washington, Howard. Montgomery and the Southern Counties. In St. Mary's County. wheat planted as late as October 8th to 18th was badly attacked. In Washington County the insect was worse in wheat planted previous to September 20th. I could find little or no fly in fields sown between September 25th and October 1st. A bulletin, giving a detailed account of this insect, with suggestions for its control, is now in press.

ENTOMOLOGICAL FEATURES OF 1897.

The first insect that attracted any considerable attention throughout the state during the season of 1897 was the clover leaf weevil. *Phytonomus punctatus.* The larvae were first observed by me here at the Station on crimson clover April 14th, but no complaints of injury were reported to me until April 22d, at which time H. O. Devries, of Marriottsville, Howard County, wrote me that they had appeared in clover fields in his vicinity, "with renewed vigor." Other reports came almost daily of their arrival in great abundance in the counties of Montgomery, Howard, Washington, Frederick, Carroll, Harford, Baltimore, Anne Arundel and Prince George. I found here at the Station April 19th several larvae of a creamy color attached to leaves; although still living, they were unable to move. I made a careful examination of them, and came to the conclusion that they were being destroyed by the fungus, *Empusa* (*Entomophthora*) *sphaerosperma*, often found on this species. From April 19th to May 12th the disease seemed to increase in intensity, and it was not an uncommon thing to find four or five dead larvae flat on the surface or curled about the edges of a leaf. They were also on the heads of clover stems, timothy, weeds and grass; in fact, anything that projected above the surface of the ground. By May 15th it was almost impossible to find a single living healthy larva, and by the 20th they had disappeared. The disease was wide spread throughout the counties above mentioned, as shown by personal inspection or examination of material sent to me.

Next in order came several species of flea beetles. A little blackish species, *Chaetocnema pulicaria*, was particularly abundant and destructive to young corn from May 6th to May 25th. They were very numerous on sugar corn and on field corn, completely ruining the first plantings in parts of Prince George, Anne Arundel, Howard, Montgomery, Kent and Worcester Counties. Another species, *Epitrix cucumeris*, was also very destructive to young potatoes, and was most abundant from May 15 to the 21. Tobacco was slightly injured by still another species, *Epitrix parvula*, the first ten days in June.

The potato stock borer was also again very abundant in upper Baltimore County, and did much damage to the early potatoes. The injury, however, was not so severe as that recorded last year.

In the tobacco growing counties of the state tobacco was very badly attacked by cut worms the early part of the season, and later by the tobacco worm, or hornblower, *Sphinx carolina*. Several experiments were performed with a poisonous mash for the destruction of the cut worms, the results of which have been published in Bulletin No. 55 of this Station. Other experiments were also conducted with the view of attracting the parent insects of the second brood of tobacco moths to a trap which had been set in the field, and in which sweetened materials, previously poisoned, had been placed, The experiments are not yet complete, and the results will be known as soon as possible.

Here at the Station I found the larvae of a beautiful little moth, *Pyrausta ferrugalis*, injuring the young tender lower leaves of tobacco in the hot bed. The larvae were abundant from July 1st, affecting usually the under side of the leaves, cutting irregular holes. When full grown, many larve cut two slits in the side of the leaf, doubled it over, and pupate within, while others transform between the leaves where they happen to be close together. The moth emerged in my breeding cages from July 6th to July 13th, the greatest number having appeared July 9th. They were most abundant on plants in the beds July 13th. They hide on the under side of the leaves, and are easily disturbed, flying quickly when approached and running rapidly to the under surface of the leaf when alighting.

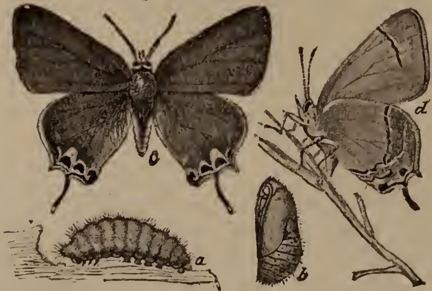

Figure 1.—Uranotes melinus. (From Howard in Insect Life.)

I found also here at the Station another insect feeding upon lima beans July 13th, which is not a very common species in this state. The insect is known as *Uranotes melinus*. The larvae are somewhat slug-like in general appearance, as shown at *a* in Figure 1, and cut holes into the pods and feed upon the beans within. Many pods were found that had been perforated and the beans extracted, but no larvae were seen in them. They are very sluggish worms, and not easily disturbed. One was placed in a breeding cage, where it pupated July 15th from which the adult butterfly emerged July 29th. Other larve were found on the beans July 28th in the same plot, and from these a number of natural parasitic enemies, *Apanteles limenitidis*, Riley, were bred August 7th.

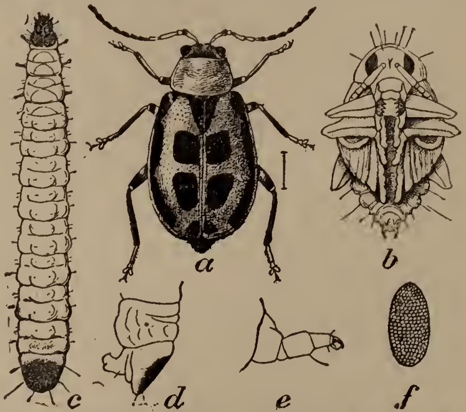

Figure 2.--Cerotoma trifurcata. (From Chittenden Bulletin, No. 9, n. s. Div. Ent.)

The bean leaf beetle, *Cerotoma trifurata*, was also observed by me May 19th in a patch of wax and lima beans near the Station. My attention was attracted to the ragged appearance of the leaves. Upon examination I found the insect, shown at Figure 2, in great abundance on the plants. The wax were more severely injured than the lima beans, nothing but the mid rib of the larger vines being left upon some leaves. The insect is easily disturbed, and drops quickly to the ground and hides when approached. The attack in this patch was local, as no beetles were found at other places in the vicinity. The ground where the outbreak occurred was surrounded last fall with cow peas, and it seems quite pos-

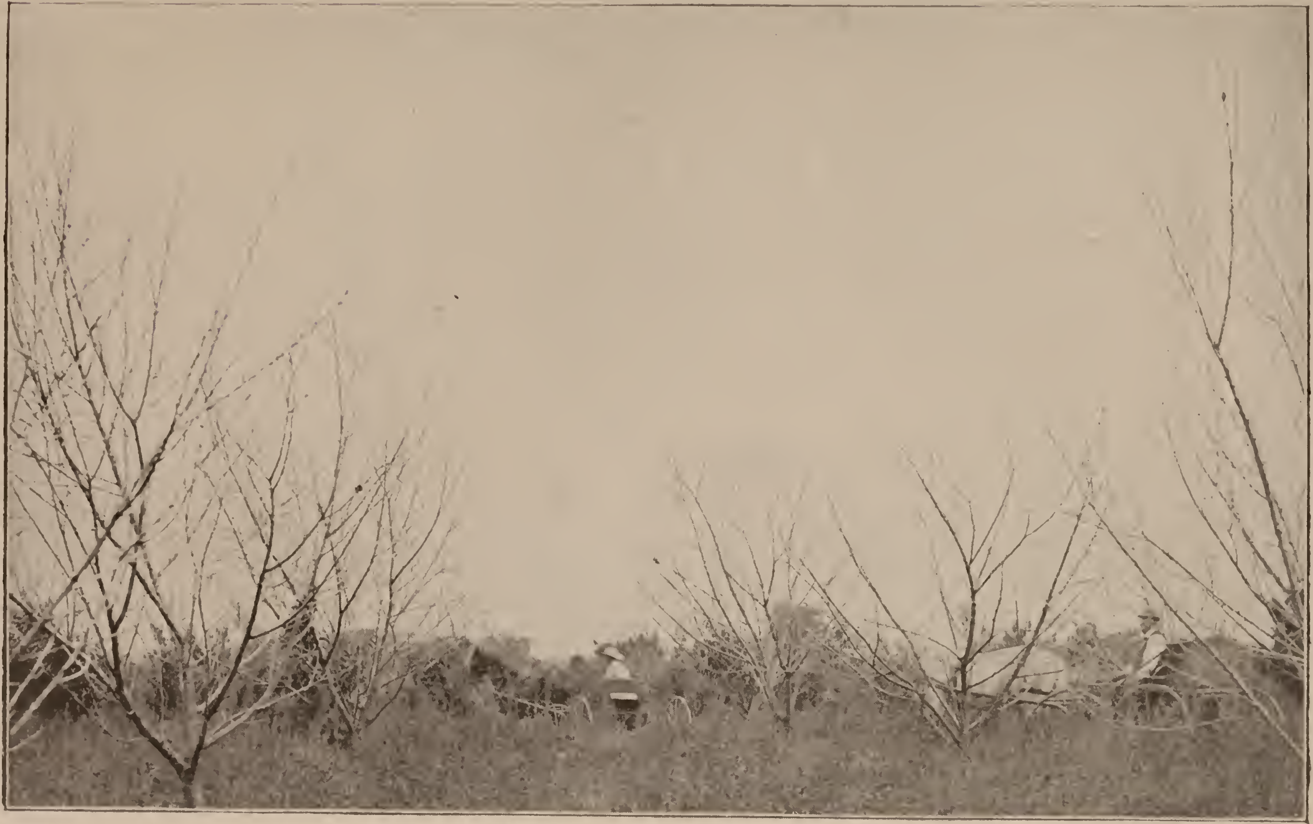

Figure 3.—View in a Maryland peach orchard of 28,000 trees killed by the San Jose scale. From a photograph taken in mid-summer (August 6, 1897), by W. G. Johnson.

sible that the beetles bred there in considerable numbers during the spring and concentrated upon the beans nearby later. Beetles, presumably of a second brood, were common on plants in the garden July 16th.

The corn crambus, *Crambus caliginosellus*, appeared in destructive numbers the early part of the season in Prince George, Cecil, Kent, Queen Anne and Dorchester Counties. In July Mr. F. H. Eldridge, of Ceciltown, Cecil County, sent specimens of the larvae and work of this insect to the Station, stating that it was doing great damage to corn on his place. July 20th I examined the corn on this farm, and found that about twenty-five acres had been completely ruined by the pest, even after the fourth planting. The young corn was perforated and eaten just below the surface of the ground, and in many instances was cut entirely off. My attention was frequently called to the ravages of this pest at the meetings of the Farmers' Institutes. A bulletin giving an illustrated account will appear this fall on this and other corn insects.

The rose bug, *Microdactylus subspinosus*, which has been a very destructive insect in the lower counties of this state for many years, appeared in large numbers the early part of June and did considerable damage to the grape crop, especially in the southern counties of the Eastern Shore. Great injury was also done by this pest to roses. In some instances peaches were attacked and injured. A series of experiments were conducted during the season, the outcome of which has not been entirely satisfactory, and will be repeated.

The pear psylla, *Psylla pyricola*, which has been very destructive to pears in certain sections of New York for a number of years, appeared in several localities in rather limited numbers in Kent County, but no serious damage was done. This is an insect which is capable of doing very great damage in a pear orchard, and close watch should be kept for it throughout the state. It is an exceedingly small insect, and occurs in such great numbers that trees, as well as the fruit, are very often badly discolored by a blackish fungus, which grows upon a sweetish liquid known as honey dew the insects exude from their bodies. Trees badly infested with this insect become sticky and gummy and soon covered with the fungus, giving them the appearance of having been dusted with soot.

In May a small beetle was found doing considerable injury to young strawberry plants near Lake Shore, Anne Arundel County. A careful examination of the creatures showed that two species were represented, *Graphops marcassitus* and *Typophorus (Paria) canellus*, and responsible for this injury. The former species is closely related to an insect which has been known to do considerable injury to strawberries in the west, and is popularly known as the strawberry root-borer, *Graphops nebulosus*.

The most prominent orchard pest during the season of 1897 was the plum curculio, which appeared in great numbers the early part of the season, and did great damage to the peach crop, especially on the Eastern Shore and tide-water section of Western Maryland. I estimated that fully one-half of the crop had been destroyed by this insect in the tide-water section of the peach-growing belt. Its absence in Western Maryland or the Blue Ridge peach belt was especially conspicuous. The orchards in that section are younger and have received better attention during the last few years than those in lower and Eastern Maryland. This same insect also did considerable damage to pears and apples, as well as plums and peaches.

The striped cucumber beetle, *Diabrotica vittata*, appeared in considerable numbers during the early part of the season and occasioned much correspondence. Its ravages were confined particularly to cantaloupes and cucumbers, although water melons and squash vines were also injured to a considerable extent.

The Harlequin cabbage bug and the strawberry weevil appear over large areas of the state in usual numbers the early part of the season, and great damage was done to the cabbage and strawberry crops. A series of experiments were conducted during the season on the latter insect, and will be included in my next annual report.

The melon plant louse and other species of plant lice, particularly *Aphis brassicae*, *A. prunicola* and *Myzus cerasi*, appeared in great numbers and occasioned much loss.

Another insect, not usually seen in this state, was bred from larvae found boring in the stems and larger branches of *Cosmos bipinnatus*, growing here on the Station grounds. The larvae were obtained from the heart of the green stem of a plant August 22d. All the branches had been burrowed out to such an extent that they were easily broken off; in fact, a slight wind readily broke the plants, and it was this that first attracted our attention. Larvae were placed in a breeding cage, and one of them pupated August 25, from which the adult insect emerged September 30th, which proved to be *Hydroccia marginidens*. These observations were of especial value, from the fact that the food plant of this insect was not heretofore known. The hollowing out of the stems and branches of the cosmos does not seem to injure the plant, so far as growth and blooming are concerned, but the difficulty arises from the weakening effect the insect has upon the plants, causing them to break readily in a slight breeze.

The fly weevil or Angoumois grain moth, *Sitotroga cerealella*, caused considerable damage to stored grain throughout the southern and eastern portion of the state. This insect has been particularly destructive to wheat and corn. A more detailed account of it, together with another insect which has done considerable damage to stored grain in this state, known as the grain or rice weevil, *Calandra oryza*, will be found in my next forthcoming report.

Notes and observations have been made upon many species of scale insects and other insects throughout the state, but it will not be possible to give an account of each species in this report, as I have now in preparation a bulletin in which I shall give a detailed account of the scale insects in Maryland, which will be published some time this winter.

THE SAN JOSE SCALE.

Aspidiotus perniciosus Comstock.

INTRODUCTION.

The San Jose scale (pronounced San Ho-zay) has caused more damage to orchards in this State than any other insect. It has been gradually spreading for the past six or seven years, and not until 1897 was there any perceptible reduction in the number of infested trees. During that year, as will be shown later, many thousand trees were destroyed and the insect was reduced to a minimum.

After making a most careful review of the damages in other States, I can safely assert that the losses sustained in Maryland by this insect have been far greater than in any other State except California. This is due, I believe, principally, to two causes: First, on account of our peculiar geographical location, we have been receiving infested nursery stock from the infested centers almost annually since its introduction into the East; and secondly, on account of its early establishment in some of our largest peach orchards, where it was silently at work several years before it was discovered.

Even in the light of all the damage that has been done here, there are many persons, and some of them professional men, who look upon the San Jose scale with an eye of unconcern and indifference. I do not wish to present this terrible pest any worse than it is, but if a person, even the most skeptical, can look at Figures 3 and 4 and read the account of this outbreak, and then reaffirm that there is nothing to fear, I am willing to make the assertion that such a person is not a capable judge to pass an opinion.

No single insect pest in this country has caused as much concern on the part of nurserymen and fruitgrowers. In my opinion, basing my statements on six years' observations and experience, the San Jose scale is the most pernicious orchard pest established in the United States. It can be controlled, however, if taken in time; but with much difficulty. The principal source of danger is the nursery, and we now have it in complete subjection in this state where it was discovered.

So much has been said and published regarding this insect by persons who have had little or no experience with it, I have considered it wise to give the opinions of several of Maryland's most successful fruit growers, whose experience with it has been such that they know about what they are talking. I shall first quote, however, what Dr. L. O. Howard, the United States Entomologist, says on this point in his bulletin (Bull. No. 3, n. s. Div. Ent. Dept. Agr.).

He says: "There is perhaps no insect capable of causing greater damage to fruit interests in the United States, or perhaps the world, than the San Jose scale. We are, therefore, justified in the assertion that no more serious menace to the deciduous fruit interests of this country has ever been known."

As this was written in the fall of 1895, I wrote Dr. Howard, November 8th, 1897, asking whether or not he had any reason for changing this paragraph from recent developments and experiments with the San Jose scale, and received the following reply November 9th: "I have seen no reason to alter the paragraph which you mention on account of any recent experience with the San Jose scale."

Mr. Robert S. Emory, of Chestertown, one of the largest and most successful fruit growers in the east, says: "I have been a fruit grower all my life, and in all my experience I have never had to contend with such a persistent, deadly enemy as the San Jose scale. It costs me annually more hard work and cash outlay than all the other insects of the orchard combined. I consider it the worst orchard pest ever established on American soil."

Mr. George K. McGaw, one of the owners of the orchards shown at Figures 3 and 4, wrote December 20th, 1897, as follows: "I cannot imagine a more deadly destructive enemy to peach trees than this insect. The 28,000 fine, healthy peach trees in our orchard two years ago, at present evidences the penalty we have paid to its introduction into this state."

Mr. Samuel H. Neikirk, of Washington county, in a letter January 18th, 1898, says: "I have never seen or heard of any orchard pest to equal this destructive creature."

Mr. Elymet Dows, of Charles county, says in a letter dated November 29th, 1897: "I very much fear this pernicious insect will ruin the fruit industry of the state.

Mr. Charles G. Biggs, of Sharpsburg, writes November 26th, 1897, as follows: "In my opinion an orchard is rendered practically valueless in three years after the scale is thoroughly established in it. While the tree may retain sufficient vitality to bear a year or two longer, the fruit itself will be so damaged by its depredations, that no self-respecting grower would want to put it upon the market, as his reputation would soon be destroyed."

Mr. L. A. Palmer, of Anne Arundel county, November 29th, 1897, says: "I know of nothing so destructive to fruit trees as the San Jose scale; besides, I am satisfied it will spread over a whole orchard in two seasons, if not checked."

Mr. James Bond, of Baltimore, who lost a large orchard from the attacks of this insect, writes November 11th, 1897, as follows: "My peach orchard before the pest attacked it was an exceptionally handsome and vigorous one, but when I looked it over this fall, it plainly showed that it was in the hands of a natural and vigorous enemy."

Mr. J. P. Blessing, a successful fruit grower in Washington county, writes December 2nd, 1897, as follows: "I regard the San Jose scale as the most dangerous insect of which I have any knowledge, and more to be dreaded than even the yellows by peach growers."

Mr. Thomas R. Hubbard, of Dorchester county, wrote me December 11th, 1897, as follows: "My opinion of the scale, as far as my limited experience will allow, is, that it is to be dreaded more than all other enemies of the orchard combined."

Many other opinions could be cited, but these will suffice to show that this insect is regarded as a serious and dangerous pest by those who have had to combat it in their orchards. I will now turn my attention to the subject in a general way, under the following heads and sub-heads:

PAST HISTORY.

This insect was first discovered and brought to the attention of the scientific public in 1880 by Professor J. H. Comstock, now of Cornell University, who was at that time United States Entomologist. He first discovered it in the extensive fruit orchards of Santa Clara County, near San Jose, California, in 1879. Referring to the deadly nature of this pest in his report (U. S. Department Agr., 1880), Professor Comstock says: "From what I have seen of it, I think it is the most pernicious insect known in this country; certainly I never saw another species so abundant as this is in certain orchards which I have visited. It attacks the bark of the trunk and limbs as well as the leaves and fruit. I have seen many plum and apple trees upon which the fruit was so badly infested that it was unmarketable. In other instances, I have seen the bark of all the small limbs completely covered by the scales. In such cases the wood beneath the bark is stained red."

While in California Professor Comstock collected a quantity of twigs infested with this insect and brought them to Washington for further study. Upon examination he found the scale was new to science, and gave it the very suggestive and appropriate scientific name of *perniciosus*, describing it in his important paper on scale insects, published in the report cited above. Popularly, he proposed to call it "the pernicious scale," and so recorded it; but from the fact that his original observations were made in the vicinity of the city of San Jose, and that the orchards in that locality were especially badly infested, the pest was soon known to the general public as the San Jose scale.

It was thought for sometime that it was introduced into California, in the neighborhood of San Jose, about 1870, by the late James Lick, upon a lot of fruit trees from Chili. About that time the same gentleman, who was much interested in forestry and fruit culture, introduced a lot of trees from Japan, and it has been asserted that the scale was probably introduced from that country. In Chili, where the pest has been found, it is asserted that it came from trees introduced from the United States. We, therefore, have no direct evidence that the importation into California came from Chili. It has been found very recently (January, 1898.) on trees from Japan (Ent. News, Vol. IX., pp. 95-96), and two very closely allied species have also been discovered there within the past two or three years. It is quite probable, therefore, that Japan may yet prove its native haunt, but if this proves true, why is it that the scale is not nearly as abundant and destructive there as here? Is is possible that some natural enemy is keeping it in check, which has not been introduced into this country? If so, then that natural enemy, whatever it may be, if established in this country, may do for the San Jose scale what the Australian ladybug did for the cottony cushion scale in California a few years ago. It is certainly worthy of investigation.

The original home of the San Jose scale is, therefore, still in doubt.

There can be no question, however, about the introduction into the Santa Clara Valley about the time specified, but it would not be good policy, from the data we have on hand at present, to state that it came from any one particular country. Eastern Asia, China, Japan, Australia or some of the islands of the Pacific may have been responsible for it.

DISCOVERY IN THE EAST.

The San Jose scale was not known in any nursery or orchard in Eastern United States previous to August, 1893. At that time, it was discovered at Charlottesville, Va. It had become established in the orchard of Dr. C. H. Hedges, who sent specimen twigs cut from the infested trees to Dr. B. T. Galloway, Chief of the Division of Vegetable Pathology, United States Department of Agriculture at Washington, thinking that the trees were affected by a fungus disease. The twigs were referred to the Division of Entomology, and Dr. L. O. Howard immediately recognized that they were infested with the dreaded San Jose scale. Upon further investigation it was found that the trees came originally from a New Jersey nursery, and a later examination of the nursery showed that the pest was thoroughly established upon the stock growing on the place. Every effort possible was made to destroy the scale at Charlottesville, in order that it might not spread to other orchards in the vicinity; but I am informed that it still exists there to a limited extent at the present time.

Very many other infested localities were discovered shortly after this announcement, including the nursery of J. T. Lovett, Little Silver, N. J., and it was soon found that the pest was very widely distributed. From the fact that it had originally gained a foothold in two prominent New Jersey nurseries, it was disseminated widely on nursery stock throughout the East.

Regarding the original introduction of the scale in the East, I quote from Bull, 3, n. s., p. 15, Div. Ent. U. S. Dept. Agr. by Howard and Marlatt, as follows: "The two nurseries responsible for the original eastern introduction of the scale, are near Burlington, N. J., and Little Silver, N. J., the one on the Delaware River, and the other on the Atlantic coast. The scale was introduced into these two nurseries in the same way. Either in 1886 or 1887, in the endeavor to secure a thoroughly cuculio-proof plum, both of these nurseries introduced from California an improved Japanese variety, the Kelsey, obtained from the San Jose district. We have the statement from the proprietors of one of the nurseries that the plum trees in question were secured in the spring of 1887 from San Jose, Cal., and were shipped through the agency of a Missouri nursery company, which acted at this instance apparently as a mere transmitting agent. The trees were unquestionably thoroughly infested when received, did not thrive, and in both cases most of them were ultimately taken out and destroyed. The stock, however, had been multiplied by nursery methods, and from the original stock, and that subsequently obtained, the scale spread more or less completely throughout both of the nurseries in question.

"In the case of one of the nurseries the scale spread to bearing pear trees, and from these had spread yearly to neighboring nursery trees. In the other nursery, fruit-growing is quite an important feature, and the scales had spread early from the introduced plum trees to bearing trees, and also infested low shrubs and plants, particularly currants of both the black and white varieties. It spread finally more or less thoroughly throughout large blocks of nursery stock. Both of these firms, when the nature of the infestation was brought to their attention undertook measures to exterminate the scale. One of the nursery companies was particularly prompt and thorough in its efforts in this direction, and deserves great credit for the manner in which it undertook the work; the other was for a time dilatory and seemingly indifferent, but was forced by the necessities of its business and by public opinion to adopt similar remedial measures."

Later investigations showed that it was also established in a number of large nurseries in widely separated states. A year after its discovery at Charlottesville, it was located in eight states. By the summer of 1895 the number had increased to fourteen, and in nearly every case the insect was traced to one of the two nurseries in New Jersey. Many new localities have been added since then, and (see Bull. 12, n. s. Div. Ent, U. S. Dept. Agr.) the insect is now known to have established itself in 33 states, including the District of Columbia, as follows: Alabama, Arkansas, Arizona, California, Connecticut, Delaware, District of Columbia, Georgia, Idaho, Illinois, Indiana, Kentucky, Louisiana, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Nevada, New Jersey, New Mexico, New York, North Carolina, Ohio, Oregon, Pennsylvania, South Carolina, Tennessee, Texas, Virginia, Washington and West Virginia. There is little or no doubt but what later investigations will bring to light new localities, as the pest seems to be very generally distributed throughout nearly the whole of the United States, and has been found in Canada and British Columbia.

DISCOVERY IN MARYLAND.

The first intimation of the presence of the scale in Maryland came to light in March, 1894, at which time Elymet Dow, of Riverside, Charles County, submitted specimen twigs infested with this scale to Dr. Howard for examination. In May of the same year another place was discovered near Neavitt, Talbot County, in the orchards of J. H. Reip. Still two other localities were determined in July of that year, near Chestertown and Still Pond, Kent County, the former in the extensive orchards of R. S. Emory, and the latter in the orchards of J. S. Harris. In November, it was found in the large orchards of Charles G. Biggs, near Sharpsburgh, Washington County, and a month later it was located at Frederick, Frederick County, and Mitchellville, Prince George County.

In January, 1895, Robert L. Gulick found it in his experimental orchards in Dorchester County. It was located at West River, Anne Arundel County, in April of the same year; at T. B., Prince George County, in August, and in another orchard near Sharpsburg in November. The aforegoing eleven localities were all that were known in this state previous to 1896.

In January, 1896, F. C. Pratt, an assistant of the United States Department of Agriculture, discovered a few infested trees near Berwyn, Prince George County. From July 1st, the time I assumed charge of the state work, to December 16th, I added eight new localities, as follows: Westminster, Frederick, Burkittsville, Mt. Lake Park, Jerusalem Mills, Ednor, Barnesville and Easton. During the year 1897 I have added to this list twenty-seven more infested districts, all of which are enumerated by counties in this report. For the first three months of 1898 that is, January, February and March, I have found fourteen more localities, and I am of the opinion that others will follow as the work progresses.

SOURCES OF INFESTATION.

From the detailed account which follows, it will be seen that the scale has established in eighteen counties out of the twenty-three in the state, representing fifty-eight localities, and involving ninety-five premises. In fifty-nine instances the source of the infestation is easily traceable to the nursery from which the trees were originally purchased. Twenty-six orchards or premises have become infested from scale-covered trees in their immediate vicinity, leaving ten orchards where there is some doubt as to the real source of the scale. It is not an uncommon thing to find trees planted in an orchard coming from three to four or more different nurseries, representing as many states, and all planted about the same time. It is, therefore, difficult to say with any degree of certainty who was responsible for the introduction of the pest under such conditions, especially where the trees were standing several years before the scale was discovered upon them.

While we know with certainty the names of most of the nurserymen who have distributed scale-infested stock in this State, it does not seem wise, indeed, it would be unjust, for us to publish their names in this connection. Such publicity would be productive of no good whatever, and would do harm to the trade in general. The nurserymen who have sent out stock infested with San Jose scale do not necessarily have that pest in their nurseries. Many cases of infestation in this state are due to stock that has been rehandled. Neither can we say that a nurseryman, who may have had the scale on his place a year or more ago, has it at the present time.

Whenever an infested tree is found all the facts concerning it are ascertained, so far as possible, and the nurseryman who is suspected is duly notified and warned. With few exceptions, the nurserymen or dealers who have sent out the San Jose scale, have done it unwittingly, and have been ever ready to cooperate with us in its control and suppression when the matter was called to their attention.

The scale is now so generally distributed in orchards, and has been discovered in so many nurseries throughout the United States, the purchaser of nursery stock, from whatever source, should be on his guard, and carefully examine every tree that comes upon his place, even though it bears a certificate of inspection.

Scale-infested nursery stock has been brought into Maryland during the last ten years from eight different states, as follows: New Jersey, New York, Virginia, Pennsylvania, Missouri, Ohio, Georgia and California. Of the infested districts, New Jersey has been responsible for

24, Maryland 19, New York 5, Virginia 3, Pennsylvania 3, Missouri 2, Ohio, Georgia and California 1 each. In 1888 there were five importations of scale-infested stock into the State; 4 of them from New Jersey and 1 from Missouri; in 1889 there was one case from New Jersey; 1890, 1 from California, 3 from New Jersey, 4 from Maryland and 1 from New York; 1892, 2 from New Jersey, 2 from Maryland, 2 from Virginia, 1 from New York and 1 from Pennsylvania; 1893, 3 from New Jersey, 3 from Maryland, 2 from New York, 1 from Virginia and 1 from Georgia; 1894, 5 from New Jersey, 2 from Pennsylvania and 1 from Missouri; 1895, 2 from New Jersey, 5 from Maryland and 1 from New York; 1896, 4 from New Jersey, 4 from Maryland and 1 from Virginia; 1897, 1 from Ohio and 1 from Maryland.

Owing to the present wide distribution of the scale it is hard to say that nursery stock is above suspicion coming from any source.

PRESENT CONDITION AND DISTRIBUTION BY COUNTIES.

ANNE ARUNDEL.

Parole:—My attention was first called to this outbreak by the owner of the orchard, Mr. L. A. Palmer, who stated at a meeting of the Farmers' Institute at Annapolis, February 25th, 1897, that he was of the opinion the San Jose scale was thoroughly established in his orchard. He said his trees consisted mostly of Dwarf Duchess pear, and that they had been declining and dying in spite of careful cultivation, and frequent mulching with manure and fertilizer, ever since they were planted six years ago, until at present not more than a dozen trees remained out of sixty originally planted. By request, Mr. Palmer sent specimen twigs to the Experiment Station for examination three days later. As anticipated, they were literally covered with the San Jose scale. I inspected the orchard March 13th, and found only nine trees of the original planting still standing, and these so literally covered with the scale it was impossible to see the bark at any one point. The other trees had died and had been dug up. A few plum and cherry trees and several currant bushes, bought and set out at the same time, were also found infested with the scale. The former were planted along a fence adjoining the pear orchard, while the latter were set out between the rows. The most of the currant bushes had died, and those still standing were so covered with the scale it was thought best to grub them out and burn them. I also suggested that it would be wise to destroy all the other bady infested trees and spray the plum, cherry and a few ornamentals near by with whale oil soap.

I could find no traces of the scale in the vicinity upon any other trees. There is no doubt in my mind but what the pest was introduced upon a few trees at the time they were purchased, and gradually spread from year to year until the whole orchard became infested.

In reply to an inquiry about the present condition of the orchard, Mr. Palmer sent me the following letter November 29, 1897: "The number of Duchess pear trees I purchased was 65, but I am of the opinion that the San Jose scale first made its appearance on two mountain ash trees, purchased from the same company and at the same time. They were planted near the pear trees. The pear trees were looking healthy and producing fruit until I dug up the mountain ash trees. The following spring I noticed that the scale had spread to all the pear trees. I know of nothing so destructive to fruit trees as the San Jose scale; besides I am satisfied that it will spread over a whole orchard in two seasons if not checked. I have not fully succeeded in exterminating the pest from my place, but think I will be able to this coming winter. I think it one of the most deadly enemies with which the horticulturalist of this state have to contend."

Crownsville:—The infestation here is in the heart of one of the largest, if not the largest, apple orchards in the state. My attention was called to it March 25th, 1897, by the owner, Dr. H. L. Mann, of Washington, D. C., who brought specimens to my home. He had first submitted the twigs to Prof. M. B. Waite, of the Division of Vegetable Physiology and Pathology, United States Department of Agriculture, who referred him to me. I visited the place March 27, and in company with Dr. Mann and his brother, N. A. Mann, who resides on the farm, made a partial inspection of the orchard, which covers about one hundred and forty acres, consisting principally of apple, a few peach, pear and plum. On the whole, the orchard was in fine condition, and the trees, two years old, had made a remarkably good growth. During the fall of 1896, Mr. N. A. Mann had noticed that several apple trees in the Ben Davis block were not perfectly healthy, and had called his brother's attention to the fact; but the matter was overlooked, and nothing further was done until the latter part of March, at which time Dr. Mann was taken to the trees, several of which had died.

A careful inspection of the orchard showed the scale was pretty generally distributed over it. Eight Ben Davis apple trees very badly infested were found in one row. Two were dead, two so literally covered that little life remained. Several trees in the rows immediately adjoining on the east and southeast, the direction of the prevailing wind, were found infested. At another place, several hundred yards away, a tree was found thickly encrusted with the pest, and from this as a center it had spread to other trees in the vicinity. A tree here and there was found throughout the orchard that contained the scale. I also examined a large number of peach, pear and plum of many varieties, but found the scale on nothing except the apple.

The infested trees were pulled up as soon as they were discovered, and part of them were brought to my laboratory for experimental purposes. The trees in the vicinity of the infested ones were sprayed with whale oil soap. There were no old trees or orchards in the neighborhood that had any trace of the scale upon them. Our general conclusion was, therefore, that the pest had been introduced upon the trees from the nursery.

West River:—In their bulletin (No. 3, n. s. Div. Entom. Agri. Dept.) Howard and Marlatt state that their attention was called to the presence of the scale at this place April 25th, 1895; but no details are given as to the extent of the attack. I, therefore, wrote Mr. N. S. Chew, the owner of the orchard, November 17th, 1897, and asked for a brief account of the outbreak.

He informs me that the pest was introduced upon the stock from the nursery, and that he made a persistent and energetic fight by spraying to subdue it, but did not succeed, as indicated in his letter which I quote, in part, below. He says that he used whale oil soap, "one pound to a gallon water," common hard soap, kerosene emulsion, and on one tree spirits of turpentine. In all, his spraying has not been satisfactory, due possibly to the fact that the solutions were not used strong enough. Whale oil soap, for instance, must be used at not less than two pounds to a gallon of water to be at all effective in the destruction of the scale, and it is even then uncertain, as mentioned in another place under remedial measures.

In his letter dated November 23d, 1897, Mr. Chew says: "Yours of the 17th instant at hand and noted. In the spring of 1892, I planted a small orchard of peach, apple, cherry, plum, pear and apricot trees, in all about 250. During that season I noticed what was afterwards pronounced San Jose scale. It first appeared on some Japan plum trees, Burbank and Satsuma, spreading rapidly to apple trees near them. As soon as I found out that it was San Jose scale I dug these trees up and burned them, but too late, as the peach trees had become infested. I tried spraying with whale oil soap, one pound to the gallon of water, without satisfactory results. It spread so rapidly that I have been compelled to dig up the whole orchard. I am sure the Japan plums were infested when received. I have not heard of the scale being any where else in the neighborhood."

Lake Shore:—The infestation at this place was brought to our attention by the owner of the orchard, James Bond, of Baltimore, who sent a specimen pear and a peach twig to Professor Robinson for examination. The material was referred to me September 20th. After some correspondence with Mr. Bond, he has furnished me the following facts, which are given here in full. He says: "I rarely visit my farm, and my information is from Mr. John F. Ellison, who farms the place. Referring to your various questions: April 1st, 1892, I bought 500 pear trees; because of weather conditions they were not set out immediately upon receipt, but were put in the earth temporarily, awaiting an opportunity to set them in orchard. When we came to set them out we found that quite a number of them were in bad condition, and we lost about 150 of the trees. The balance, 350 trees, were planted next to peaches, at the foot of a tract known as Peach Orchard Hill, and in a patch of young raspberries. The patch of raspberries was destroyed (burned) last spring, after which the entire pear (350) and peach (900) orchards were infested. Upon examination, in company with Mr. Ellison, we concluded that the pest was so bad that the only chance of preventing its spread to neighboring orchards was to destroy by fire the entire orchard. This determination was arrived at about the 16th of October, and I assume that the destruction has been completed. Mr. Ellison has examined the other orchards and raspberry patches on my place, and failed to find any further evidences of the San Jose scale. My understanding was that you were to visit that section, and I trust you may be able to make the visit at an early day, so that we may know the exact condition. In a conversation with Mr. Ellison he informed me that the pear trees were infested when they were brought on the farm; that in searching for the cause of so many dying he noticed what he now knows was San Jose scale, but knew nothing of the pest at the time."

"I cannot now answer your question as to how many trees were killed outright by the pest. The peach orchard, before the pest attacked it, was an exceptionally handsome and vigorous young orchard; when I looked it over this fall it plainly showed that it was in the hands of a natural and vigorous enemy."

"I instructed my assistant, Mr. Sherman, to make an examination of the remaining trees on Mr. Bond's place March 2, 1898. One tree in an orchard of about 500 peach trees, five years old, was found very badly infested, and the scale had spread to the trees immediately surrounding it. A young peach orchard of about 100 trees, set out last spring near by the old infested trees, is now more or less attacked by the scale. Have advised that the young trees be given a thorough washing with whale oil soap as soon as possible.

St. Margaret's:—This locality came to my attention in February, 1898. Mr. H. A. Tydings sent me a peach twig cut from an infested tree, asking for information regarding it. The twig was literally covered with the young partially-matured females, and presented a blackish and dirty appearance. I wrote Mr. Tydings February 18th, asking more definite information regarding the outbreak, and received the following reply: February 21st. "The twig I sent you a few days ago did not come from my place, but was cut from the orchard of my neighbor, Mr. A. A. Stinchcomb. The insect seems to be confined to young trees set out last spring. The varieties affected are Troths, Early St. John, Elberta, Crawford and Smock, and were grown by Mr. Stinchcomb in his garden. There seems to be about twenty-five hundred trees affected, with other large orchards in the vicinity. Your presence is very desirable soon."

I proceeded to Mr. Stinchcomb's February 24th, and made an examination of his orchards. I found a very bad condition of affairs. He had grown about 2,500 peach trees in his garden, near his house, one year ago, and planted them in his orchard last spring. In three blocks the trees were kept together, while many others were used to replant in older orchards where the trees had died. Wherever I examined the trees I found fully one-fifth of them were infested. In some instances the bark was literally covered with the pest. After a most careful examination of the surroundings I ascertained the source of the infestation in a small apple and plum orchard in his garden. Part of the trees were purchased about ten years ago, and had made a good growth. Others had been bought from a New York firm and planted about five years ago. The majority of these trees were encrusted with the scale, some of them being dead. The pest had spread to nearly all the trees in the vicinity. The majority of them were so much stunted and reduced that no system of treatment could save them. Mr. Stinchcomb removed them, leaving only a few apple and plum trees that were moderately infested. No scales were found on a couple of English walnut trees near by.

It was clear that the scale came from these infested trees. Mr. Stinchcomb tells me that he first noticed that something was wrong with some of his young peach trees about the middle of February. He was standing in one of his young orchards, and saw a tree some little distance away that looked grayish and unhealthy. Upon examination he found it encrusted with "some kind of a creature," which he could scrape off with his thumb nail. He called the attention of his neighbor, Mr. Tydings, to the tree, and a specimen twig was sent to me as indicated above.

My suggestion was that all the trees should be examined, and wherever the scale was found upon one it should be destroyed by grubbing up and burning, as they were worth commercially only about six cents apiece, and the cost of the treatment would not pay. All the others were then to be trimmed and washed with whale oil soap before the buds began to open. Mr. Stinchcomb had a block of nursery stock, containing about 1,500 peach trees near one of these infested orchards, which he desired to plant this spring. I told him I would fumigate these trees with hydrocyanic acid gas, and arranged to do the work in a small room in a tight building near his house. The room was plastered and well adapted to the work, as explained later on. All the young nursery stock was placed in this room and fumigated. At Mr. Stinchcomb's suggestion, the entire lot of 2,500 peach trees planted last spring were taken up, examined thoroughly by my assistant, Mr. Sherman, and fumigated March 4th, 5th and 7th. All the badly infested trees, about 500, were cast aside and used for experiment purposes or burned. The trees, about 2,000 in all, were then replanted in the orchard.

Bowie:—I found one peach tree near this place January 21st, 1898, that was slightly infested. The source of the scale could not be determined. No other trees in the vicinity and the surrounding orchards could be found that contained a trace of the scale.

South Baltimore:—The scale at this place is in the heart of a block of 600 two-year-old peach trees, belonging to Elias Stallings. Our attention was called to it in a letter to Prof. Robinson from Dr. H. M. Revell, of Annapolis, March 12th, 1898. May 14th I detailed my assistant, Mr. Sanderson, to make an inspection of the orchard and surrounding orchards. Only three trees were found infested, and, as they were in a very bad condition, it was suggested that they be taken up and destroyed. So far as could be determined the scale had not spread to any other trees in the orchard, although many of them are under suspicion, and a close watch will be kept of them during the season.

Marley:—My attention was called to another orchard in which the San Jose scale was supposed to have gained a foothold in the vicinity of South Baltimore, by Dr. H. M. Revell, of Annapolis, March 12th, 1898. I detailed my assistant, Mr. Sanderson, to visit and inspect this orchard and the surrounding premises May 18th, 1898. The orchard belongs to Mr. Frank Revell, and contains in all about 1,500 trees, mostly peach. Of these, one small orchard particularly, containing 449 trees, was found very badly infested. 136 trees were dead, 91 in a very depleted condition, while 222 were still living. A young orchard had been planted in the immediate vicinity of these trees, and the scale was also found upon the first two or three rows. In another block, containing 432 trees, the scale is quite generally distributed throughout. In another block of five or six-year-old trees, the scale is just beginning to make its appearance in the southwest corner. Immediate steps will be taken to check and control the pest at this place, and Mr. Revell has been advised that nothing will be left undone to assist him in every way possible.

BALTIMORE.

St. Denis:—While inspecting some young trees at this place August 13th, 1897, I found a box containing 4,000 King of Thompkin's County apple buds, which had been recently received from an Ohio nursery. After a careful examination of these buds, I found upon several of them unmistakable evidence of the presence of the San Jose scale, and brought the material to my laboratory, where I made microscopic mounts in order to examine and verify my identification. Although the buds were not badly infested there were enough live scales upon them to have infested any block of apple into which they would have been budded. The buds were immediately destroyed, and thus the introduction of the pest in this locality in a large nursery avoided. The nurseryman from whom the buds were purchased was immediately notified, as well as the Entomologist of that state. Upon inquiry I am informed that the scale was found scattered here and there throughout the block of apple from which the buds were cut. In justice to the Ohio nurseryman, it is but proper to say that nothing has been left undone to suppress and exterminate the pest on his premises.

Landsdowne:—A single cherry tree at Earleigh Heights, A. A. Co., was found badly infested with the San Jose scale by David Fetter in a small orchard which had been planted in the spring of 1897. A specimen twig cut from this infested tree was sent to me March 17th, and I found it very badly attacked with the scale. The tree was destroyed, and I am informed by Mr. Fetter that so far as he can ascertain with the aid of a hand lens, he has been unable to find any indications of the insect upon any of the other trees in the vicinity. Fortunately, this block contained only 19 trees. An examination of this orchard May 18th, 1898, by my assistant, Mr. Sanderson, revealed the fact, that one other tree, a pear, was badly infested, which was removed.

Still another infested orchard was discovered at this point belonging to Mr. Scott. A peach and a pear tree were thickly covered with the scale. One badly infested peach had been removed the previous week. All the trees containing scale were marked and have been removed.

Ruxton:—A twig containing scale insects was referred to this office April 19th, 1898, by Thomas J. Lea, of this place, for examination and reply. I found it quite badly infested with San Jose scale and asked for detailed information as to the number of trees in the orchard, on whose premises they were located, from whom they were purchased, and when they were set out. Not receiving a prompt reply, I detailed Mr. Sanderson to inspect the orchard May 17th, 1898. It was ascertained that the scale was located in a small orchard of about 50 trees, belonging to Mr. Vail. They had been discovered on a peach which had been destroyed. An examination of the surrounding trees showed that the pest was also established on plum and cherry in the same orchard. All the infested trees were marked, and are to be destroyed or sprayed with whale oil soap.

CAROLINE.

Greensborough:—At a meeting of the Farmers' Institute, held at Denton, January 20th, 1897, Mr. H. L. Cohee, of Greensborough, told me after looking at specimens of the San Jose scale under a microscope, that he had the same pest in his orchard, but did not know what it was. I asked Mr. Cohee to send specimen twigs to the station for examination. February 1st, a package containing several pear twigs, which came from the infested orchard, was received. Upon further inquiry, I found the trees, all pear, of the following varieties: Kieffer, Bartlett and Idaho, had been purchased and set out in the fall of 1892. Mr. J. C. Russell and Mr. J. C. Mitchell, both of Greensborough, purchased trees of the same varieties, and at the same time, and in every instance the Idaho pear was found to have been infested. Of ten trees of this variety planted by Mr. Cohee four of them had died from the effect of the scale, and others were badly infested. The scale was introduced on the Idaho pear from the nursery.

In a letter dated November 22nd Mr. Cohee says: "In reply to your letter of the 17th instant, will say that I still have a few scale upon my trees. February last I cut the trees within a foot and a-half of the ground, and gave the remaining stumps a scrubbing with soft soap and carbolic acid. They have made from three to five feet growth this season. Upon close examination recently I found the scale still present in small numbers upon three out of five trees. I have been to see Mr. Russell and Mr. Mitchell, and find their trees still infested with the pest, but I cannot see that it has spread. One of the parties dug up the infested Idaho pear trees and planted other trees in the same place, and I find they now have a few scales upon them."

Federalsburg:—March 6th, 1897, Mr. John Manning, of Federalsburg, sent me twigs cut from Abundance and Satsuma plum in his orchard, that were literally covered with the scale. The orchard contains about one hundred trees, principally plum and apple, planted three and four years ago. Many of the trees died prematurely, and the weak, unhealthy condition of the others attracted attention of the owner. Under date of March 10th I made reply, and gave due warning as to the deadly nature of this pest, and urged the necessity of prompt action for its check and control.

Mr. Manning writes me November 23rd, as follows: "I am in receipt of yours of the 17th instant, and I am sorry to say that I still have some of the San Jose scale. One apple tree purchased in the spring of 1895 is very badly infested. The tree came from the same nursery as the original stock, samples of which I sent you last spring. I burned those trees on the spot they grew, and I intend to try to get rid of the pest this winter."

Preston:—Mr. A. H. Larimore, of Easton, reported to me April 17th, 1897, that he had found a bad case of the San Jose scale on Japan plums on the place of Mr. Willett Harris, of Preston, and that some of the trees were dead. The scale had also spread to other trees in the vicinity. Upon the receipt of this communication I wrote to Mr. Harris April 22d, asking for twigs from the infested trees for examination, but have had no reply up to the present time, March 14th.

CARROLL.

Westminster:—September 9th, 1896, I discovered this pest on a tree on the premises of the Rev. S. A. Diehl. As I was passing the place my attention was first attracted to a peach tree, one-half of which was apparently dead, and upon close examination, I found it completely encrusted with the scale. Fortunately for the owner, not more than fifteen trees were involved, all of which were planted in his garden and yard. My letter of the 30th instant to Mr. Diehl explains the attack somewhat in detail, and I quote part of it herewith:

"On the 9th instant I discovered the dreaded San Jose scale on peach trees growing in your yard in the rear of your residence. It is not necessary for me to say that this pest threatens the destruction of our fruit industry, unless it is speedily checked.

Many bulletins have been published regarding it, and, no doubt, its natural history is familiar to you. It is to be regretted that this, the worst of all orchard pests, has established itself in your county. Heretofore it was not known to occur in Carroll County, and we will leave nothing undone to suppress it and check its further spread in your vicinity. The importance of the attack on your place is intensified from the fact that there is an extensive nursery near by.

"A careful examination of all the trees on your place shows that the scale has found lodgment on them. I was sorry you were not at home while I was there, but I fully explained the whole matter to your wife, and I presume you understand the interests at stake, and have acted accordingly. If you have not destroyed the peach trees next to the fence near the lane, I would advise you to have them dug up and burned at once. There is a small apple tree near the peach tree nearest the house badly infested. This also should come out; in fact, I would suggest that all the badly infested trees on the place be destroyed. The trees in the chicken yard are very badly infested with both the San Jose scale and the scurfy bark louse. There is a pear tree in the corner of the lot near the chicken yard that is in very bad condition. The currant bushes in this corner are almost literally covered with the scale.

"The old peach tree along the walk near the house, and which has been cut back, is badly attacked with that dangerous disease known as Yellows. No time should be spared in the destruction of this tree, root and branch.

"As I suggested to your wife, some of the trees can, no doubt, be saved, but it will necessitate a vigorous pruning and a thorough application of whale oil soap. This soap can be bought at from three to five cents per pound, and should be applied in the autumn as soon as the leaves fall, at the rate of two pounds to a gallon of water. It should be put on hot, and with a good spray pump. This treatment should be repeated in the spring just before the blossoms appear.

"We can hope to keep this pest in check only by the most energetic and persistent fighting. I am very anxious to know from what source the peach trees came, especially those near the lane, as they seem to indicate that the pest was upon them when planted. Any information you can give me will be greatly appreciated. If I can be of any future service to you in your warfare against this pest please command me."

In reply to the above I received the following letter from Mr. Diehl November 23d: "Your letter dated September 30th, was received October 1st. Before having received your letter of instruction, in fact, the morning after you were here, I took up and burned the two peach trees near the lane in the garden and also the little apple tree and pear tree in the garden near the fence of the chicken yard. The other trees I thought might be saved by proper treatment.

"Now, first, as to the origin of the pest; that you did not see. It was an apple tree presented to me by Mr. Edwin Lawyier, a neighbor, last spring, three years ago. It soon showed the scales, the nature of which I did not fully understand. I gave it a good scrubbing with wood ash lye, which cleaned it up for the time being, but a year later it was almost as bad as before, and did not grow. I then dug it up and burned it. Mr. Lawyier told me that it came from Mr. Parry's nursery in New Jersey, if memory serves me right. Then Mr. Stoner gave me the apple tree which had also taken the disease as a natural consequence. The peach nearest the house, along the lane, I bought from the Peters nursery, Adams County, Pa. It was a clean tree, I have reason to believe, when I received it, and got the scale from the apple tree which stood near by. The large peach tree on which you first discovered the scale grew there from seed within four years, and got the bugs from either the apple or other peach tree. The large tree which was cut back, and which you say had the yellows, I also destroyed. Last week the leaves were about all off of the other trees, so I gave them a heroic, or as you say, vigorous trimming back, then prepared the whale oil soap solution, and with a paint brush carefully painted trunk, every branch, and what twigs were left, so that they looked as though they were whitewashed. I also thoroughly coated the currant bushes. Mr. Stoner says he will get a spray pump and spray the trees for me next spring. I shall hereafter keep a sharp lookout for the indication of the presence of this nasty pest. The other peach tree in the garden, where the large diseased one stood next to the walk, remained healthy in appearance, and yielded most excellent fruit, a large, yellow, sweet peach. Mr. Stoner pronounced it Smock. The storm broke about one-third of it down which I removed, and now have done all that I can do to save the remaining part of the tree from the scale. Since the rain washed some of the soap off the trees they look nice and clean. Thanking you for your definite and very satisfactory instruction. I remain, sincerely yours, in the warfare against the Devil and also against the San Jose scale bugs."

I made another examination of the trees remaining on Mr. Diehl's place September 8, 1897, and again on October 3d. I found a plum and three peach trees still attacked by the scale, even after the heroic treatment that had been given them. The plum, although a small tree, was thickly covered with scales, and has since been destroyed; while the peach trees will be sprayed again this fall.

The pest has also spread from here to trees on several adjoining premises. In the garden of Mr. J. Shafer I found it thickly covering a peach tree about four years old, and a plum tree two years old. There were also several peach seedling that had come up voluntarily in the garden, and these were found infested. Several large apple trees and a grape vine in the same garden contained the scale. I advised Mr. Shafer to destroy the badly infested trees in a letter dated September 9th. At the time of my visit, October 3d, I found the peach tree had been destroyed, and several large limbs on the infested apple trees had been cut off; but the infested plum tree, peach seedling and grape vine still remained. After some little urging Mr. Shafer was induced to destroy all the infested plants.

The scale was also found on apple on the premises of Mr. John Zengraft, and on apple, pear and peach trees in the garden of Mrs. G. Snowden. Both parties were given due notice of the presence of the dangerous pest, and advised to spray the infested trees with whale oil soap. At still another place I found several hundred two-year--old Ben Davis apple trees infested, all of which were uprooted and burned.

CHARLES.

Riverside:—The specific determination of the scale at this place was made in March, 1894, by Dr. L. O. Howard, the United States Entomologist at Washington. Mr. C. L. Marlatt, an assistant, was at once detailed to examine the orchard, which is situated on the river front, and is owned by Mr. Elymet Dows. It covers an area of about twenty acres, consisting of about two thousand peach and several hundred apple trees. The trees were purchased in the fall of 1887 and planted the spring of 1888. At the time of Mr. Marlatt's visit many of them had died from the attacks of the scale, and had been destroyed. The pest, however, had spread to other parts of the orchard. On account of the nearness of this infested orchard to Washington, it was used by the Division of Entomology of the Department of Agriculture for experimental purposes.

In response to a recent letter in regard to the present condition of the orchard, Mr. Dows writes under date of November 29th, as follows: "Yours of the 17th instant received, in which you request an account of the present condition of my orchard, to what extent it has been infested, from what source the outbreak occurred, and my opinion of the San Jose scale as a destructive orchard pest.

"The insect was brought to my place from the nursery, and this occurring before the pest was known in the East placed me at a great disadvantage. For two or three years I saw something was wrong (many trees dying), and tried various remedies, but found my orchard going from bad to worse. I then took samples to the Agricultural Department, Washington, D. C., where Professor Howard at once became interested in the subject, and with the assistance of Messrs. Marlatt and Coquillett made numerous experiments and many examinations (see Bulletin No. 3 by Professors Howard and Marlatt), and on finding whale oil soap the most effective remedy, advised its use, since which I have used it every spring on my trees, and feel certain I have the pest under control, and the living trees are at present in a fairly healthy condition.

"In looking at the matter from a business and a paying standpoint, my experience is that small trees may probably be successfully dealt with, but large, badly infested trees can not. In my case the cost so far has been $5 for every cent of income, and I should not have fought so persistently but for my constitutional objection to defeat.

"In regard to the spreading of the insect from my place to that of the persons you mention I am unable to say, not having studied that part of the subject; but if the nursery from which their stock was received was clear, and I have heard nothing to the contrary, should consider Professor Howard's idea the right one."

At the time of Mr. Marlatt's first visit, so far as could be determined, the orchards in the neighborhood were free from the insect. In October, 1895, however, he found that two young peach orchards belonging to Mr. Robert Marbury and Mr. W. D. Swan, about a mile south of Mr. Dow's place, were slightly infested, and the general conclusion was that the pest had been carried there by birds or insects from the orchard of Mr. Dow.

July 23, 1896, the writer accompanied Messrs. Marlatt and Schwarz, both assistants of the Division of Entomology, Department of Agriculture, to Riverside, where they had been detailed to examine and report upon the condition of a colony of predaceous insects, *Scymnus marginicollis*, which had been imported from California and liberated at that place.* The orchard of Mr. Marbury was carefully searched for the little ladybug, but not a single specimen was procured. The grass and weeds were swept with a net in the vicinity of the trees where the insects had been liberated, but not one was discovered. The orchard was in very bad condition, having been neglected somewhat on account of its unhealthy condition. About five hundred trees were found literally covered with the scale in all stages of development. The young were crawling in great numbers, and in one instance a small black ant (*Monomorium minutum*) was seen carrying a partially matured female in its jaws. Adults and larvae of a little blackish ladybug (*Pentilia misella*) were also observed running around over the infested trees, but none were seen feeding upon the scale. The orchard contained about one thousand trees, many of which were badly injured by the peach tree borer, while others were dying from the attacks of Yellows. In all, the orchard presented a very pitiful sight.

Many trees in an adjoining orchard belonging to Mr. Swan had also died from the attacks of the scale, and leafless trees, dry and hard, were dotted here and there throughout the orchard. The present condition of the orchard is given in the following letter received from Mr. Marbury November 22d, 1897. He says: "Replying to your inquiry of November 17th, will say that my orchard originally contained 1,000 trees. I estimate that 750 are now dead or dying, and the grubbing hoe will finish the rest. The peach crop I consider the poorest we can undertake to raise in Southern Maryland counties. I knew nothing of the nature of the insect, and gave up in disgust, when I found the orchard was attacked by it.

Nanjemoy:—While in Annapolis, February 9th, I learned that the orchard of Dr. S. H. Speake, of this place, has been infested with this scale for some time. In reply to my letter of inquiry, February 11th, Dr. Speake says under date of February 17th, that his orchard has been infested with San Jose scale, and that nearly all of his trees have been killed. The trees originally came from a Virginia nursery, and without doubt the scale was introduced with them, as he says "the trees in another part of the farm, coming from a different place, did not have the scale."

I wrote again for specimen twigs for examination, which were duly received and found infested with the genuine San Jose scale. Dr. Speake wrote me March 4th, as follows: "I mailed you a few days ago some twigs, cut from my peach orchard of 1,200 trees. The branches of the trees are nearly all killed by the San Jose scale, but new growth is starting from the body of the tree. It first commenced in two rows of trees. I think Heath Cling, and spread slowly over the orchard. I intend when I cultivate the land again, to cut down or grub out all the trees in the orchard."

Mason Springs:—The infestation at this point was upon nursery stock from New Jersey, purchased the spring and fall of 1896. I visited

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*An attempt was made to introduce *Rhizobius debilis (lophantrae,)* but the insect proved to be *Sycmnus marginicollis*.

the place of Mr. F. T. Maddox, March 15th, 1897, and made an examination of his orchard. I found the scale clustered upon one Lawrence pear, which had been planted the fall previous, consequently the scale had not spread to other trees. It was uprooted and burned. The pest was not found upon any other trees on this place.

In a young orchard of Mr. H. Turner Rowe, a near neighbor, I also found the scale thickly encrusted upon a Lawson pear that had been planted in April, 1896. Another tree, a Lawrence pear, planted in November, 1896, from the same nursery, was also infested, showing without a doubt that the tree was infested when it was planted. Mr. Rowe was instructed to dig up and burn the infested trees.

Still another infested orchard in this locality, the trees having come from the same source as the above, four and five years ago, came to my attention March 26th, 1897, at which time Mr. G. E. Medley sent me twigs cut from his Bartlett pears for examination. In a letter March 29th, I advised the destruction of the badly infested trees and the spraying of all suspicious ones with whale oil soap. All the young trees in the orchards of Messrs. Maddox and Rowe were also sprayed with whale oil soap, as advised, and we believe we have checked the spread of this pest in this locality.

In a letter dated November 19th, 1897, Mr. Maddox says: "In reply to yours of the 17th instant, regarding the San Jose scale, would say that Mr. Rowe, Mr. Medley and myself think the soap you sent us entirely eradicated and destroyed it, as we fail to find any symptoms of the scale on our trees now, after carefully watching them. I used the soap three or four times on mine with paint brush. They have made wonderful growth and look very healthy."

CECIL.

Perryville:—While in the upper part of Cecil County, September 17th, 1897, I learned incidentally that Mr. George W. Sutton, of Perryville, was of the opinion that he had the San Jose scale in his young Duchess pear orchard. I called upon him the same day and made an inspection of the trees and found four of them dead from the attacks of this pest. The scale had spread to all the other trees, and they were in such a serious condition I advised their immediate destruction. There were only twenty-five trees in the lot, purchased and set out one year ago last spring. Fortunately there were no old trees in the immediate vicinity, and the introduction of the scale at this point was made upon the trees from the nursery, and from present indications has been destroyed at this place.

DORCHESTER.

Linkwood:—The outbreak at this place is in the orchard of Mr. Robert L. Gulick. The pest seems to have been introduced upon nursery stock purchased the spring and fall of 1888, but its presence was not definitely determined until January, 1895. At that time, Mr. Gulick took specimen twigs to the meeting of the Peninsular Horticultural Society, and the pest was identified by Mr. Marlatt. The orchard contains many varieties, and was inspected by me March 30th, 1897. I found it in very bad condition. Many trees had been cut back to the trunk and the scale was very generally distributed. I observed it here upon the largest number of varieties of any place in the state, including peach, pear, apple, plum and quince. Many of the trees are dwarfed and stunted, having made little or no growth.

Mr. Gulick has fought the pest persistently since 1895, but has not succeeded in exterminating it. He has used large quantities of potash lye in water, at the rate of one pound of lye to two and three gallons of water, washing the trees by hand. I found many living scales upon trees washed with the weaker solution, but where the stronger solution was used, a very small percentage of living insects remained.

I made a second inspection of this orchard August 26th, and did not find nearly as many live scales. The whole orchard has been treated with lye and water at the rate of one pound to two gallons. Only an occasional scale could be found upon trees that were literally covered in the spring. Many insects had been destroyed, evidently by some predaceous enemy, as the scales had been ruptured. I saw no insect responsible for the work.

In reply to a letter of inquiry, regarding the number of varieties in his orchard that were infested, Mr. Gulick wrote me January 24th, as follows: "The following is the list of varieties of trees infested with the San Jose scale: *Peach:* Old Mixon, Mystery and Early Rivers; *Quince*: Fuller's Orange, Meeches, Alaska and Champion. *Pears*: Big Seckel, Duchess, Anjou, Lawrence, Louise Bonnie and Mt. Vernon. *Plums*: Ogon, Botan, Maru, Kelsey, Abundance, Yosebe, Silver Prune, Spalding, Tour Sweet Botan, Burbank, Satsuma, Botankio, Hattankio, Chabot, Lombard, Free Stone Dawson, Roulette, Newman, Williard, and Whitaker. *Apples*: Nyack Pippin, Fourth of July, Early Ripe, Stayman's Winesap, Yellow Bellflower, Gano, Ben Davis, McCullough, Rome Beauty, Lawyer, McNash, Talmon Sweet, Arkansas Black, American Blush, Red Cider. Winter Banana, Grimes Golden, Springdale, Vandevere, Black Twig, Newtown Pippin, Carthouse, Wine Sap, Nashville, Mammoth, Robinette, Spitzenburg, Baldwin, Salome, Nansemond, Beauty and Florence Crab. The list of plums is not quite complete. The total number of trees in the infested orchard is 750. I think the spread of the insect is very slow where there are few on a tree. When they become numerous, they find means of getting to favorite varieties of trees. A small number of insects will stunt the growth of small trees, and the most impoverished condition of infested trees is in November and December."

There are thirty-one infested varieties of apple in the above list, twenty of plum, six pear, five quince and three peach, making a total of sixty-three different varieties in all.

Cornersville:—The infested orchards at this place belong to Mr. Thomas R. Hubbard and Mr. D. L. Moore. My attention was first called to the condition of the trees by Mr. A. H. Larrimore, of Easton, who noticed their depleted condition. He wrote me September 4th, 1897, stating that he believed the orchard was infested by the San Jose scale. Upon receipt of this information I wrote Mr. Hubbard September 9th to send me sample twigs from the diseased trees. He complied with my request September 27th, and I found the twigs badly attacked by the deadly enemy. After some further correspondence I have ascertained the following facts:

Mr. Moore writes November 29th, as follows: "Yours of the 27th received and contents noted. Will say in regard to your inquiry that some of my trees are affected with the San Jose scale. I have only about two dozen trees, and I think about half of them are more or less affected. Those which are effected most were purchased about eight years ago.

In reply to my letter of inquiry, Mr. Hubbard writes me the following December 11th: "My orchard consists of the following named trees, viz: 100 apple, 30 plum, 50 peach, 75 pear and 13 quince, 273 in all, and I do not believe there are a dozen trees but what are infested with the scale.

"This orchard was planted in November, 1891. I noticed in planting that two of the apple trees had some patches of a dark gray substance on them that could be scratched up with the finger nail. I did not know what it was, not being familiar with the scale; in fact, had not heard of it being in Maryland; but in the summer of 1893 I noticed these trees failing, and upon examination I found them completely covered with the scale. My opinion is that the pest was brought from the nursery. I am thinking of topping all my trees this winter and covering them with soft soap. What do you think of the idea?"

I advised Mr. Hubbard to use whale oil instead of soft soap. The latter has been used to good advantage in many instances, but the former is very much more satisfactory.

Cambridge:—January 22nd, 1898, Mr. W. G. Dawson wrote me from Cambridge that Mr. Thomas P. Peters, near that place, had an orchard which was infested with the San Jose scale, and that he intended to cut down and burn all the infested trees. Upon receipt of this information I wrote Mr. Peters January 25th, asking for more detailed information regarding his orchard, and received the following reply February 25th: "I herewith enclose specimen twigs of last year's growth cut from my peach orchard for your examination. I am not positive what the difficulty is, but from what information I gained at the Farmers' Institute in Cambridge, I pronounce it the San Jose scale. About one-half of my trees are dead, and most of the others infested. I do not know of any other orchard similarly affected in this vicinity, but think they must be, as I have heard people complaining of their trees dying rapidly. Please let me know when you expect to be in this county, as I would like to be at home at the time of your coming."

The twigs Mr. Peters sent me were badly infested with the San Jose scale, but fully 95 per cent. of them were dead when received. The scales were rather whitish and collapsed. I could not ascertain the cause, as it certainly was not due to parasites or predaceous insects, and no indications of fungus disease. In reply to my later inquiry, Mr. Peters wrote March 4th, as follows: "I am in receipt of yours of the 1st instant, and in reply will say, that it is very discouraging to know that I have such a destructive pest with which to contend. The trees, 225 peach, 12 pear, 12 plum and 6 quince, were purchased from a New York firm, and the scale first appeared upon them. I also had about 725 other trees which seemed perfectly healthy until lately. I do not think the scale has any choice as to variety of peach, and that tree seems to be the ideal breeding place. Fully three-fourths of my peach trees are infested. At this writing I am not prepared to say whether there is anv scale on the plum, pear or apple."

Ellwood:—The infestation at this point is in the orchard of V. S. Vickers. April 21st, 1898, I received information of such a nature that I felt quite sure that the insect had gained a foothold in this orchard. and in reply to my inquiry of April 23rd, Mr. Vickers sent me twigs cut from the orchard, and I found them very badly infested with the scale. The orchard was set out about three years ago. I wrote another letter of inquiry on the 30th, asking other questions regarding the trees and the general conditions of the surrounding orchards.

FREDERICK.

Frederick City:—The infestation at this place is supposed to have come on plum trees purchased in April, 1893. Mr. D. W. Coquillett, of the United States Department of Agriculture, inspected the trees December 27th, 1894, and found the scale still present upon some of the original stock. Mr. Coquillett made a second examination some time later, and was unable to find any further indications of the scale, the stock originally attacked having been destroyed.

I made a careful examination of the trees on this and other places in the vicinity September 10th, 1896, and found a very bad state of affairs. The scale was found upon cherry, apple, peach, pear, plum and quince. Some of the trees were literally covered with the pest, and a two-year-old cherry tree (Napoleon Bigarreau) had been killed. There is no question but what the scale was introduced upon stock from the nursery. An examination of trees in the gardens of several persons living in the vicinity revealed the fact that the pest has spread to a considerable extent.

Several peach trees in a lot belonging to Mr. Frederick Kintz were very badly infested. It was found also on plum trees in the yard of Mr. E. M. Dyer, and upon peach in the gardens of Messrs. P. R. Renner, D. S. Rice and L. F. Kussmaul. It was also noticed upon a small peach tree in the yard of Mrs. John Holmes. A bulletin (No. 42, Maryland Experiment Station) containing information about this insect was sent to each of the above named individuals, and attention called to the presence of this dangerous pest upon their premises.

At the time of my visit, September 28th, 1896, I found all the infested trees on the premises where the pest was originally introduced had been destroyed; but several infested peach trees on adjoining lots were still standing. The attention of the owner was again called to the necessity of immediate action for their destruction.

I made another inspection of these places September 3rd and 4th. 1897, and found that the scale was still present. Two peach trees on the lot belonging to Mr. Dyer were literally covered. These trees were also infested with the terrapin scale (*Lecanium-negro-fasciatus*). I advised Mr. Dyer in a letter September 9th that it would be

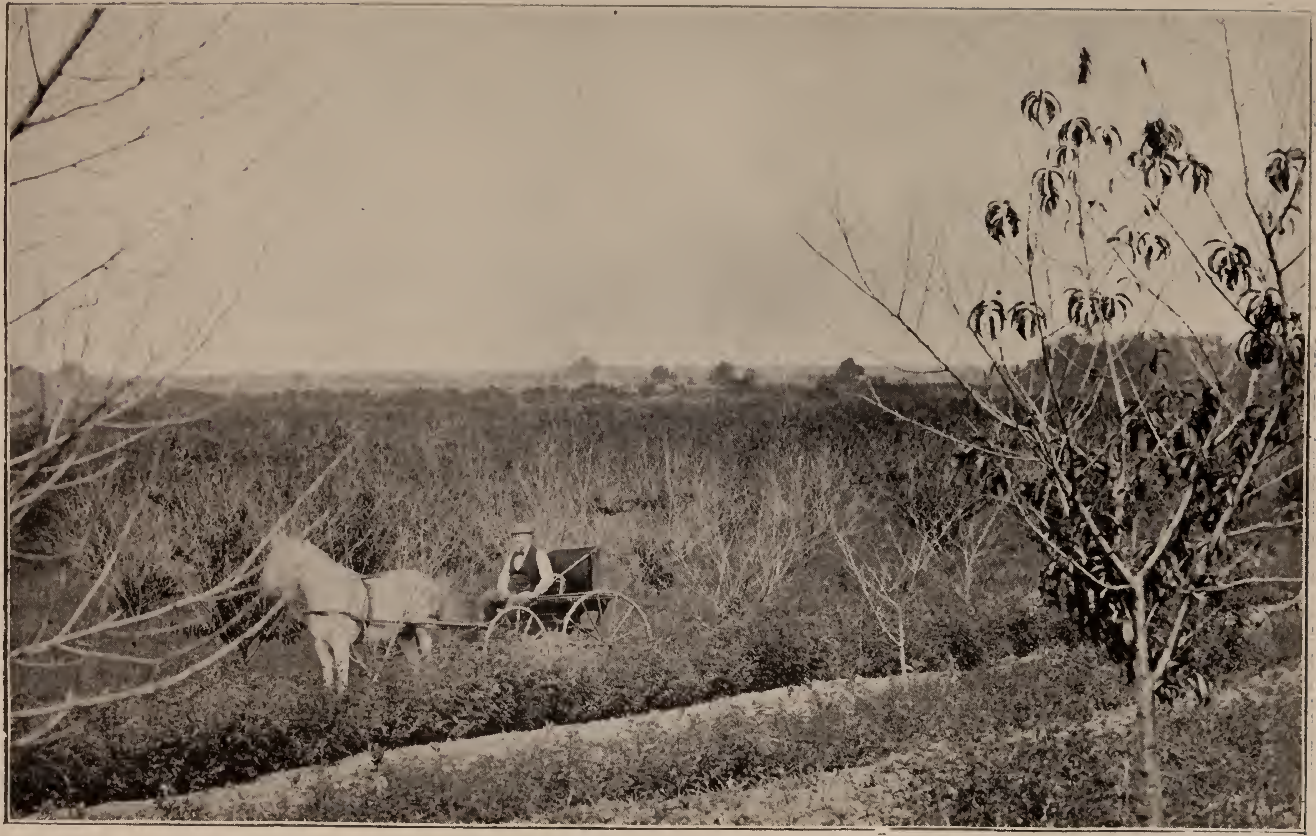

Figure 4.—Scene in a 300 acre peach orchard destroyed by the San Jose scale. Very few trees with any signs of life. From a photograph taken August 6, 1897, by W. G. Johnson.

good policy for him to destroy the trees, not only for his own protection, but also that of his neighbors. The scale was also present in small numbers upon an old peach tree in an adjoining lot. Several apple trees on the farm of Mr. Hock, a few miles north of Frederick, were found infested, all of which were uprooted and burned. There is some doubt as to the source of the infestation at this point.

My attention was called to another infested orchard in the vicinity of Frederick March 8th, 1897. The owner, Mr. Samuel T. Hargett, wrote Mr. W. L. Amoss, Director of the Department of Farmers' Institutes, who referred the matter to me. The orchard contains about four hundred trees, from five to seven years old. Speaking of the trees, Mr. Hargett says: "Among them I discovered three only which I considered diseased. Symptoms of the disease, rough, scaly bark, with body and branches like sample enclosed. If convenient, please let me know what is best to do with them?"

I immediately wrote Mr. Hargett, stating that the insect responsible for the injury to his trees was the San Jose scale, and advised him to take immediate steps for its control. He replied March 10th that he would begin spraying with whale oil soap, as suggested, and endeavor to check its further spread.

In a letter to me, dated November 30, 1897, Mr. Hargett says: "The infested trees were sprayed with whale oil soap as directed. I gave them two applications, and I believe I have the scale under control."

While in Frederick I also learned of the presence of the scale upon some trees on the premises of Mr. J. W. Keller. I made an examination of the place, and found the pest upon a few peach trees in the yard. The insect seems to have been introduced about two years ago upon pear trees which have since died and have been removed.

Another infestation near Frederick was brought to my attention by Mr. H. B. Witter January 25th, 1897. The trees belong to Mr. G. M. Hedges, and were planted in his yard and garden near his house four and five years ago. Mr. Hedges was aware of the fact that the trees were not healthy; but not until January 16th did he know what caused the trouble, at which time he received a letter from Dr. L. O. Howard, the United States Entomologist, in reply to his query of January 11th.

I made an examination of the premises September 5th, 1897, and found that Mr. Hedges had dug up and destroyed several pear trees which had been badly infested. There were several pear and apple trees still standing, all of which had been attacked. They had been pruned and washed with a double dose of whale oil soap. There were still a few living scales upon them, but the trees were in such miserable condition I suggested it would be economy to uproot and burn them. The scale had also gotten on an osage orange hedge fence near by, and Mr. Hedges had burned it on both sides for a distance of several rods.

March 21st, 1898, I received a number of twigs cut from a plum tree in a small orchard of about 80 trees, belonging to Mr. D. C. Winebrenner, of this place, asking information regarding the disease which he found upon them. On examination I found that they were pretty badly infested with the San Jose scale, and upon making further inquiry, I found the trees were planted in the spring of 1895. Directions were given for the immediate destruction of the badly infested trees and treatment for the others.

Araby:—While in Frederick September 5th, 1897, I heard that an orchard in the vicinity of Frederick Junction was dying out from some mysterious cause. I drove to the place, and found Col. Carroll Mercer, the present owner, but he could give me little or no information about the orchard, as he had just recently purchased the property. The orchard is beautifully located on the side of a hill, and contains about twenty-five hundred trees. Several hundred trees in the western end of the orchard were dead or dying from the attacks of the San Jose scale. Many trees have been dead for several years, and it was not difficult to locate the trees which bore the original infestation. The pest had spread over about two-thirds of the orchard, many of the trees still living, but literally encrusted.

I called upon Mr. J. H. Gambrill, the former owner of the place, and he informed me that the trees were planted in the fall of 1891 and spring of 1892. He said that there was little or no doubt in his mind that the pest, since it had been called to his attention, had been introduced upon the stock from the nursery. He stated that he had noticed the trees were unhealthy in this particular section of the orchard from the time they were first planted, and that he had paid especial attention to this section, worming, fertilizing and plowing, as he supposed the difficulty was due to some soil conditions.

Several hundred of the trees in the badly infested portion of the orchard made a beautiful growth for the first three or four years, and were then gradually killed out, dying from the tops downward. On many trees a vigorous new growth had sprung up from the trunk, which gave them a very peculiar appearance. The leaves on this second growth were unusually large, some of them measuring nine inches in length and from two to two and a-half inches in width. This dense green foliage growing from around the base of the trees was very striking as it stood out in contrast with the dead and leafless branches.

I made a second examination of this place October 9th, and in company with Colonel Mercer went over the orchard quite thoroughly. He was much surprised to find the pest so widely distributed, and was much interested in the attack, as it was the first he had ever seen. At the time of this visit I found that Colonel Mercer had been worming and working around the base of the infested trees, hoping that he might, by this treatment, restore them to their former vitality. I assured him that he was simply wasting time, as the deadly nature of the insect would soon sap the life from the tree in spite of all the worming and fertilizing he might do. I also assured him that there was but one remedy for trees where they were as badly infested as those in the greater part of his orchard, and that was their immediate destruction, especially those trees which were so literally covered that little or no life remained. I told him there was a possibility that he might save part of the orchard by spraying persistently year after year, but conditions were against him, and it was doubtful whether it would pay him to do it.

Burkittsville:—The outbreak at this place was called to my attention by the owner of the orchard, Mr. H. W. Shafer, who wrote me, as follows, December 14th, 1896: "You will find enclosed cuttings from a few apple trees. Can you tell me what is the matter with them? The orchard is about six years old, and some of the trees are apparently dying from this scab. Please advise me what to do for them."

Upon receipt of this letter, together with the infested twigs, I wrote Mr. Shafer December 19th, stating that his trees were infested with the San Jose scale, and gave him the necessary information for the treatment of the orchard.

In a letter dated December 28th, Mr. Shafer states that the trees were apparently vigorous until the summer of 1895. Up to that time he says, he never saw trees grow faster or look better. In all, about one-half of an orchard of one hundred trees is infested with this pest. No other orchard in the vicinity is known to contain this scale, and there seems to be little or no doubt but that it was introduced upon the nursery stock at the time it was purchased, as it came from a nursery that is known to have been infested for several years past.

GARRETT.

Mountain Lake Park:—I discovered this insect at this place in a block of one hundred plum trees September 7th, 1896. Only two of the trees were found badly infested, and from general appearances the scale had not been able to hold its own at this altitude, Oakland (2,391 feet). These trees came originally from a nursery in one of the Northern States, and so far as a careful examination went, the scale had not spread to a block of five hundred apple trees, two hundred pear trees and one hundred cherry trees in the immediate vicinity. The infested trees were uprooted and destroyed immediately.

These trees were again examined by me October 5th, 1897, but no further traces of the scale could be found, and I am of the opinion that it has been entirely exterminated at this point, probably due, as stated above, to the high altitude, and other conditions which exist in this mountain district.

HARFORD.

Jerusalem Mills:—The following letter from Mr. Harold Walsh, dated October 27th, 1896, explains the nature of the outbreak at this place: He says: "I enclose herewith section of a twig taken from a Japan Golden Russet pear growing on an adjoining farm. I think it is infested with the San Jose scale. Am I correct? The tree is three years old, and the trunk is entirely covered with this scale. Kindly let me hear from you?"

Immediately upon receipt of this, I wrote Mr. Walsh, under date of October 29th, as follows: "Yours of the 27th instant, with enclosure is at hand, and in reply would say that you are correct in your identification of the San Jose scale. The twig you send is badly infested with this insect. I would like to have further information regarding this outbreak, and will be greatly obliged to you if you will ascertain, if possible, how many trees are in the immediate vicinity of the infested one from which the sample was taken. Judging from the looks of the specimen before me, I am of the opinion that the pest has spread to a considerable distance in your neighborhood."

In reply to the above, I received the following letter, dated November 17th, from Mr. Walsh: "Please pardon the delay in answering your favor of October 29th. The tree from which specimen of the San Jose scale was taken stood in the center of a block of twenty-eight pear trees. The owner has made a careful inspection of the remaining trees with glass, but found no San Jose scale. He tells me that there are other scales present, such as are often seen upon trees. All the trees in question were planted the spring of 1895."

From other information which I have in hand, there is no doubt but what the scale was introduced at the time the trees were purchased from the nursery. This conclusion is further substantiated by the fact that the nursery from which they were purchased is known to have been badly infested with this pest for several years past.

The present condition of this orchard is told by Mr. Walsh in a recent communication, dated December 1st, which is as follows: "In reply to your favor of November 23rd, I am glad to be able to say that the orchard you refer to is entirely free of the San Jose scale. There was, I think, but one tree infested with the scale, and that was dug up, root and branch, and destroyed by burning. The above was the only outbreak of the San Jose scale in this neighborhood of which I am aware."

Pylesville:—The infested trees at this place were discovered by the owner, Mr. E. A. Wilson, who sent specimen pear twigs to Professor Robinson, who referred them to me. I found them very badly attacked by the San Jose scale, and immediately notified the owner, and asked for more definite information. In reply I received the following letter, February 18th: "Yours of the 17th instant at hand, and I am very sorry to note that I have the San Jose scale in my orchard. I suppose the sooner I begin fighting it the better. It was pronounced the oyster shell scale by a nurseryman who was at my place some time ago. I have about sixty trees, and they were bought about four or five years ago from a Pennsylvania nurseryman." My second letter was dated the 19th, and I advised the destruction of all the badly infested trees, and the spraying of the others as soon as possible with whale oil oap.

HOWARD.

Annapolis Junction:—The outbreak here is in the extensive orchards of Col. W. S. Powell, and was first called to my attention October 30th, 1897, by Mr. M. B. Waite, Assistant Pathologist of the United States Department of Agriculture, who had noticed the insects upon some plum trees in the orchard October 9th, at which time he addressed the Vansville Farmers' Club, which met at Col. Powell's residence.

I visited this place November 6th, and made a careful examination of the trees. Col. Powell informs me that this orchard was planted in the fall of 1893, and contains fifty Abundance plums, fifty Botankio plums, one hundred and ninety York Imperial apples, ten Early Ripe apples, two hundred and fifty Kieffer pears, two hundred and fifty Bartlett pears and four hundred Champion quinces.

Currants, gooseberries and asparagus have been planted between the rows in the lower part of the pear orchard. This attack is explained in full in my letter of November 8th to Colonel Powell, which is as follows: "As a result of the examination of your orchard Saturday last, I am obliged to inform you that I found the San Jose scale thickly colonized upon half a dozen plum trees, and has spread from these to all the other plums in the same block. I did not have time to examine every individual tree, but found it wherever the inspection was made in the plum orchard. I found it also on pear well down the hill, showing beyond all doubt that it has spread to a considerable extent. It is also upon a few quince trees in the immediate vicinity of the plum. I did not see it upon apple, but feel sure it has found lodgment there, especially on the side between the plum orchard and your house.

"The scale seems to have originated upon a few plum trees. I believe we can check the spread of this pest in your orchard, and it will be a pleasure for me to undertake this task, if you will permit me to superintend the work, the only condition being that the necessary labor and a few chemicals be furnished by you."

The next day I received the following letter from Col. Powell, which explains itself: "I am in receipt of your letter of November 8th, and thank you for same. I had regularly examined the orchard up to about June 1st last, and then, to my eye, there was no scale, but on last Sunday, after your visit, I went through the orchard, and was horrified to find its extent in the plums. Of course, I accept your proposition for the experiments you wish to make in this orchard, and really, owing to its central location, and all being young trees, I should think it would be a valuable object lesson, not only for the members of the Vansville Farmers' Club, but to all nearby farmers who have been watching the orchard's growth with considerable interest. Just have your whole outfit consigned to me, let me know what chemicals you need and what assistance you will want, and I will promptly make the arrangements."

Dayton:—April 11th, 1898, I received a letter from Mr. W. F. Bergman, of this place, enclosing specimen twigs cut from an apple tree for examination. Upon one of them I found a cluster of eggs of the katydid, and the other was thoroughly infested with the scurfy scale. Mr. Bergman intimated in this letter that he had several plum trees which were infested with a scale similar to the one on apple. Although I did not question the accuracy of Mr. Bergman's determination, I felt in justice to him that it would be better for me to have specimen twigs from the plum trees in order that I might examine them and make sure the insect was the same as that found on the apple. As a rule, it is not easy for the average observer to distinguish the different species of scale insects. I had a suspicion that the insect upon the plum was possibly the San Jose scale, and upon receipt of the twigs, which arrived April 18th, I found that my suspicion was well founded, as the twigs were very badly infested with that insect. I immediately wrote the gentleman the result of my determination, and advised him what to do.

KENT.

Chestertown:—The occurrence of the scale at this place is in the orchards of Robert S. Emory, one of the largest (if not the largest) and most succesful pear grower in Maryland. Captain Emory was aware of the presence of the insect in his orchard for several years, but did not ascertain definitely what it was until July, 1894, at which time he brought it to the attention of Mr. C. L. Marlatt, of the United States Department of Agriculture, who was at his place making some studies upon the Psylla, another insect which is very injurious to pear.

The scale was introduced into this orchard upon two hundred and fifty Lawson pear trees, purchased October 26th, 1888, of Parry Bros., Parry, New Jersey. At the time the trees were received Captain Emory noticed that they were not as clean and healthy looking as other trees which he had purchased from other sources. The trees were planted, however, under complaint as to their inferiority. They did not make the usual normal growth, and Captain Emory was of the opinion that they were infested with some contagious disease; but was not aware of the nature of the disease until later, as noted above. He became alarmed in 1892, noticing that the disease, whatever it was, had spread to other blocks of trees in the same neighborhood, and began an extensive series of experiments, unaided, for the suppression of the mysterious disorder. Thinking it a species of scale insect, and having a supply of whale oil soap on hand, which he had been using against the pear leaf slug, he applied this material as a winter wash to every suspected tree. He coated the trunks and larger branches with soap which he had diluted with water to a consistency of thick soft soap.

In August, 1894, the pear Psylla, an insect very injurious to pear trees, was doing much damage in Capt. Emory's orchard, and he called on Dr. Howard for assistance, who detailed Mr. Marlatt to make an investigation of the outbreak. It was at this time that Mr. Marlatt's attention was called to the scale, and after treating many trees for the Psylla he began some experimental tests upon the scale. While Mr. Marlatt was engaged at this work Captain Emory called his attention to the whale oil soap treatment of 1892, and prepared some of the material to show him. One of the trees that had been badly infested, and originally treated with the soap, and which still bore a few scales, was again treated in October. The tree was healthy and had made a beautiful growth, although it still retained some of the old scales, and showed plainly the characteristic purplish marks made by the pest.

At first Mr. Marlatt expressed considerable surprise at the heroic treatment which Captain Emory had given the trees, stating that had he applied the material in solution it would, in his opinion, have destroyed the trees. As a result of this conversation, Howard and Marlatt began an extensive series of experiments with whale oil soap for the destruction of this scale in Captain Emory's orchard, and in a large peach orchard at Riverside, Charles County, Maryland, infested with the same pest, reported in detail in their Bulletin (No. 3, n. s. Div. Ent., U. S. Dept. Agr.).

In the fall of 1895 Captain Emory followed up his experiments with whale oil soap, varying his operations somewhat by using a spray pump for applying the substance to the trees in a fine mist. That season he used over seven barrels of the soap. In the fall of 1896 he again sprayed every tree in the infested block with soap, at the rate of 2¼ to 2¾ pounds* to a gallon of water, using in all about fourteen barrels, or about 5,600 pounds. The fall of 1897 he used five barrels of soap, spraying the blocks where the scale had gained a foothold, which were not fumigated with hydrocyanic acid gas. In spite of the heroic treatment which Captain Emory has given the infested trees in his orchard, the scale has spread to a block of 2,050 six and eight-year-old Bartlett pears, 200 Lawrence pears, and has recently been found in a block of 2,500 Duchess pears, which has been fruiting for over thirty years. A few scattered specimens were also found upon a block of 140 Mountain Rose peach trees, which have been fruiting annually for the past five years. It has also gained a foothold in a block of Marietta peach trees which were planted four years ago. A few scattered specimens of the scale were also noticed this season in a block containing 1,000 Howell and a few other mixed varieties of pear. It was also found in another block of 2,000 Duchess and Bartlett pears, and upon a few trees in a block of 200 Manning's Elizabeth and 400 Buffum. In all, Captain Emory has succeeded in keeping this pest in check, but has not exterminated it.

The fall of 1897, the entire lot of Lawson pears still standing in the original block upon which the pest was introduced were uprooted and burned. These trees were destroyed partly from the fact that this variety is not considered a profitable one in Capt. Emory's locality. They were also slightly infested with the scale, and it was thought best to destroy them, together with several old apple and other trees in the vicinity, which had become infested.

A block of 450 Kieffer pear trees, planted by the side of the Lawson, from which the scale spread to all the other varieties in the immediate vicinity, have so far, been comparatively free from the attacks of this pest. After careful and repeated examination by Capt. Emory and myself, we have been unable to find a living scale upon any of these trees, with two exceptions, April 15th, 1897, after we had spent more than half an hour going over the trees in the row and along the side next to the infested Lawson block, we found four scales upon a sprout which had grown from the trunk of the tree. Three of these insects were males, and the remaining one a female, and all were alive and in apparently good condition. At another time, June 17th, 1897, we cut a sprout from one of the Kieffer trees, which contained a half dozen male scales and four females, all of which were alive. None of these trees had been sprayed. It also appears that the Le Conte pear in this locality, is practically immune from this insect, as no trace of it could be found in a block of fifty trees which were planted between a block of Lawrence and Manning's Elizabeth, both of which were slightly infested.

In the fall of 1894, Capt. Emory ordered a second lot of pear trees from the same nurseryman, from whom he had received the original lot of infested Lawson. He had been informed that the scale had been entirely eradicated from the nursery, and that the trees were perfectly healthy and in good condition. Upon receipt of the trees, Capt. Emory made a close inspection, and found them infested with the same scale. To make sure of his identification before he reported the affair to the nurseryman, he referred the matter to Dr. Howard, the U. S. Entomologist, who detailed Mr. Coquillett, one of his assistants, to proceed to Capt. Emory's place and personally examine the trees in question. Mr. Coquillett found the trees badly infested with the genuine San Jose scale. They were destroyed, and the matter was immediately referred to the nurseryman, who acknowledged he had the scale in his nursery. From recent reports, we are informed that the pest is still present in the same nursery, although heroic measures have been resorted to for its extermination.

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*This strength destroyed most of the fruit buds and some wood.

As stated above, the pest is still present in Capt. Emory's orchard to a limited extent, but every possible effort is being made to exterminate it. Through the generosity of Captain Emory and help from the Experiment Station, a long series of experiments with hydrocyanic acid gas were conducted in this orchard last fall, to which reference is made under the proper heading at another place in this report.

A recent examination of a young peach orchard belonging to Mr. H. M. Brown, planted last fall a year ago in the immediate vicinity of Capt. Emory's orchard, shows that this pest has gained a foothold upon a few of the trees. Mr. Brown's attention has been called to it, and I have written him that it will be wise for him to take some immediate action for the destruction of the pest before it spreads to other parts of the orchard, as it is now confined to the first few rows on the side adjoining the block of Bartlett pears belonging to Capt. Emory.

May 5th, 1898, Capt. Emory informed me that C. J. Reiche had three Bartlett pear trees on his place in Chestertown which had been killed by the San Jose scale. He stated that he examined the trees and that there was no question of doubt about the identity of the species. Recently, Capt. Emory received a letter of inquiry from Mrs. C. J. Ringgold, of Chestertown, stating that some insects was injuring trees which had been planted in her garden and asked for information as to what was best to do for its suppression and control. I wrote Mrs. Ringgold May 7th, that I would visit her place and make an examination of the trees and suggest the best method for controlling the insect at that time.

Still Pond:—Howard and Marlatt (Bul. No. 3), record the occurrence of the scale in the orchard of Mr. James S. Harris at this place. The correct identification of the species in this case was not ascertained, as the trees were destroyed before a specific determination had been made. In reply to a recent query, Mr. Harris says under date of November 29th: "Your letter in regard to insects on my trees is received, and the facts in the case are as follows: I bought a small lot of Lawson or Comet pear trees the same season that Capt. Emory planted his Lawson, that brought and spread the San Jose scale over his orchard. My trees were planted with Kieffer on both sides of them and a long distance from other varieties. They were badly infested with some kind of small scale insect that prevented them from growing as they should grow; and when Capt. Emory's were found to be infested with San Jose scale, I burned mine. I do not know what scale it was on my trees, but after several years of good cultivation, they were very little larger than when they were planted. The insects did not trouble the Kieffer that were on each side, but they grew finely from the first, and I have seen no signs of insects on them up to the present time. I bought the Lawson from a local dealer, and understood from him that they came from the same nursery from which Capt. Emory purchased his."

Sassafras:—While attending the annual meeting of the Peninsular Horticultural Society at Snow Hill, January 15th, 1898, Mr. James T. Shallcross, of Middletown, Delaware, told me that his brother, Jacob T. Shallcross, who resided near Sassafras, Kent county, Md., had an orchard badly infested with the San Jose scale. Upon my return to my office, January 17th I wrote Mr. Shallcross, and received the following reply January 18th: "Yours of the 17th instant at hand, and contents noted. I had an orchard of about five thousand pear trees eight years old, and so badly infested with the San Jose scale, that I took the entire orchard up and burnt the trees last winter. I still have about one thousand pear trees left, which look pretty good so far."

MONTGOMERY.

Ednor:—The occurrence of the scale at his place was first called to my attention by Dr. Howard, who had received specimen twigs of peach and pear infested with this insect, from Mr. E. P. Thomas. Immediately upon receipt of this information, I wrote Mr. Thomas, giving him due warning as to the dangerous nature of the pest, and called his attention to a recent Bulletin, (No. 42), which we had just issued, and further stated that I would be at his place in a few days to make an examination of the infested trees.

In company with Director Miller, of the Experiment Station, I inspected Mr. Thomas' orchard December 8th, 1897, and found that his trees were very badly infested. The trees, about 200 in number, were planted in the spring of 1894, and from the beginning, Mr. Thomas noticed that some of the pear trees, of which there were 150, were not perfectly healthful. Several of them died in 1895 and from these the scale seems to have spread to other parts of the orchard, as all of the trees were found more or less infested. There were about 50 peach trees in the lot, and part of these were literally encrusted with the scale.

Owing to the very bad condition of the trees, I assured Mr. Thomas that it would be economy in the long run to grub them up and destroy them at once, for if an attempt was made to save them by any system of spraying, the cost of such operation repeated year after year, would be more than the trees were worth. He decided later that it would be policy to destroy the entire orchard before the insect spread to other trees in his neighborhood. So far as I can ascertain, I could find no trace of the scale in the young orchard belonging to his brother, who lives near by. The infestation here was another case of the introduction of the scale directly from the nursery, as the trees came from one that is known to have been infested at that time.

Barnesville:—At the meeting of the Farmers' Institute at Rockville, December 22nd, 1896, Mr. C. C. Mainhart, of Barnesville, told me, after looking at a specimen twig containing the San Jose scale, that he was of the opinion that he had the same insect upon young trees in his orchard. Upon request, Mr. Mainhart sent me some twigs cut from his Japan plum trees January 7th. The insect, as suspected, was the San Jose scale, and Mr. Mainhart was given due notice regarding it. I visited his place April 6th, 1897, and made an examination of his orchard. I found the pest upon about 50 plum trees, the attack being very much worse upon the Japan varieties—Burbank, Satsuma and Abundance, than upon Wild Goose and Marianna. None of the trees were dead, but several were so badly infested that they had made little or no growth, and looked very sickly.

I found the same scale upon seven peach seedling about two years old in the same orchard, but did not find it upon any trees in the old orchard in the immediate vicinity. All the trees were thoroughly washed with whale oil soap, and I understand from Mr. Mainhart, that he has almost entirely destroyed it. In reply to my recent letter of inquiry, he says December 8th: "The whale oil soap saved my trees. I have watched them carefully this summer, and while there are a few scales upon them, still they are few and far between, as compared with their condition this spring. I wish you could see the trees now that were so badly infested last spring. I gave them a double dose of whale oil soap and they have made an unusual growth.

"I wish to say, however, that the soap as I applied it, killed all the blossoms and fruit buds; but later, they put out a new growth, and I never had trees look any more thrifty. To give you an idea of the wonderful growth, will say that some of them have put out over five feet of new wood quite regular over the trees.

"On the whole, I am well pleased with my success. While there are some scales upon the trees, yet I believe that another application of the soap will entirely destroy them."

At the request of Mr. John W. Brown, who resides near Barnesville, Mr. Mainhart took me to his place to see some trees which he desired me to examine. I went over his entire orchard, and found one tree, an Idaho pear, which was very badly infested with the scale. A lot of damsons had been bought at the same time, but I could find no trace of the insect upon any of them. The infested tree was dug up and burned, and the others in the immediate vicinity were washed with whale oil soap for fear that some of the insects might have escaped us.

Mr. Mainhart then took me to the farm of Mr. C. C. Brosius, who had also made a purchase of trees two years ago, the most of which, from some mysterious cause, had died. Mr. Brosius was of the opinion that they had been killed on account of the dry weather that followed shortly after they had been planted. An examination of some of the dead trees showed that they were litterally covered with the San Jose scale, and those still alive, were also infested with the same pest. In all, Mr. Brosius had purchased about 75 plum trees, 100 pear trees, and a few gooseberry and currant bushes. As noted above, all the plums and damsons were dead or badly infested with the scale, as were also all the currant and gooseberry bushes. I was unable to find any trace of the scale upon the pear trees planted at the same time in an adjoining orchard. The infested trees and bushes were in such a dwarfed and stunted condition, it was not thought worth while to try and restore them, and they were destroyed.

Brookville:—This outbreak was brought to my attention by Robt. L. Miller, who brought me a twig of an apple tree which had been referred to him by Mr. J. B. Hallowell, of Brookville. The twig was very badly infested with the San Jose scale. April 28th, 1897, I wrote Mr. Hallowell, stating that it would be to his interest to make every effort, without delay, to check and destroy this ravenous pest, and also made inquiry as to the number of trees in the orchard.

Under the date of May 4th, in answer to my query, Mr. Hallowell says: "Your esteemed favor of April 28th, duly received. The orchard contains about 75 apple trees, and a few pear and peach. 50 of these trees were planted in May, 1891. and 29 in April, 1893. I think several more are infested, though not so badly as the one, a cutting from which I sent you, though I lost one about three years ago, near the one now badly infested, and which I now believe had the same disease."

May 6th, I wrote to Mr. Hallowell, asking whether or not he would permit me to try some new soaps which had been made for me by the Powell Fertilizer and Chemical Co., of Baltimore, in an experimental way upon his trees. May 13th, Mr. Hallowell replied that he was entirely willing for me to try the experiments upon his trees, and suggested that I come to his place as soon as possible. I proceeded to the infested orchard May 15th, and began my experimental work the following day, which is reported in detail at another place in this report. I found the scale on 11 trees, two of which were very badly infested; one planted the spring of 1891, and the other April 15th, 1893. The trees made a beautiful growth, but two of them appeared to be diseased, and finally died two years ago, when they were dug up and burned. There is no doubt in my mind that the scale was introduced upon these trees, as those that are now infested are in the immediate vicinity of the places where the others were removed. Many of the twigs and limbs on the two badly infested trees were dead, and the limbs, in most cases, were literally covered. The insect was still present in this orchard August 28th, the time at which I examined a lot of twigs sent to me for that purpose. Other experiments with whale oil soap were performed in this orchard this spring.

Oakdale:—Dr. Mahlon Kirk, of this place, called the attention of Director Miller to several trees in his yard June 20th, 1897, which were supposed to be infested with the San Jose scale. The matter was referred to me by Mr. Miller June 21st, together with a specimen twig cut from one of the infested trees. I wrote Dr. Kirk the same day that the insect was the genuine San Jose scale, and gave him the information desired regarding it, and received the following communication from him June 26th: "Your letter of the 21st instant was duly received, for which I am much obliged. Mr. Miller examined the trees referred to, at my request, as I felt quite sure there was something very wrong with them. I had my suspicions aroused, but as I had not seen the San Jose scale, I felt uncertain about the trouble. He advised the use of whale oil soap, and the next day I applied it thoroughly. A day or two passed, and still feeling uneasy, as he had pronounced it an undoubted case, I concluded to treat the case heroically, and cut the trees down to within two feet of the graft, and put every leaf and stem in the stove, fragments at a time. I have again and again washed the stumps with the soap, and have bandaged them from the ground to the top, which bandages I soaked with the solution, and which I shall renew from time to time, so if there is any virtue in the soap for the trees, I hope to get it. I treat them in this manner, hoping, as the trees are a peculiar, and said to be a valuable variety, they will send off shoots from the stumps, which may still give me the apple."

Garrett Park:—Dr. L. O. Howard informed me July 16th, 1897, that Mr. Dorsett, of the Division of Vegetable Pathology, had brought him twigs from a Japan plum from the place of Mr. J. T. Allen, of Garrett Park, that were badly infested with the San Jose scale.

I wrote Mr. Allen, July 17th, stating that I would visit his place as soon as possible and make an examination of the infested trees and assist him in the destruction of the pest.

Wheaton:—The infestation at this place is in the orchard of Mr. John S. Case. He brought specimen twigs cut from an infested peach and pear tree to the station September 15th, 1897. I made an examination of this orchard, in company with my assistant, Mr. Sherman, December 8th, and found the entire orchard of 400 trees more or less infested. These trees were planted about three years ago, and were purchased from a local agent who represented a northern nursery. There seems to be little or no doubt but that the pest was introduced upon a few Idaho pear trees. Mr. Case informs me that these trees did not look healthy when he received them, and that they did not make the growth that they should, and finally several of them were dug up and destroyed. The pest has spread from this centre to all parts of the orchard, the trees in the vicinity of the original infestation being either dead at present or literally incrusted with the scale. The pear trees which are planted in alternate rows between the peach are also badly infested, but not to the same extent as the peach. I suggested that a number of the badly infested trees, which were also attacked by the yellows, should be dug up and destroyed. About 100 of the badly infested pear and peach trees will be used by me for experimental purposes; the rest of the orchard will be sprayed with whale oil soap, and every effort possible will be made to check and destroy this ravenous pest before it spreads to other orchards.

It was with difficulty that the scale was found upon Kieffer pear trees, which were surrounded by badly infested peach trees. It is certainly apparent that trees of this variety in this locality are practically free from the attacks of this pest. The little black lady bug (*Pentilia misella*) was quite abundant upon the infested trees.

Fairland:—Mr. Wilson G. Johnson, of this place wrote me October 20th, 1897, making inquiry for a remedy for the destruction of the

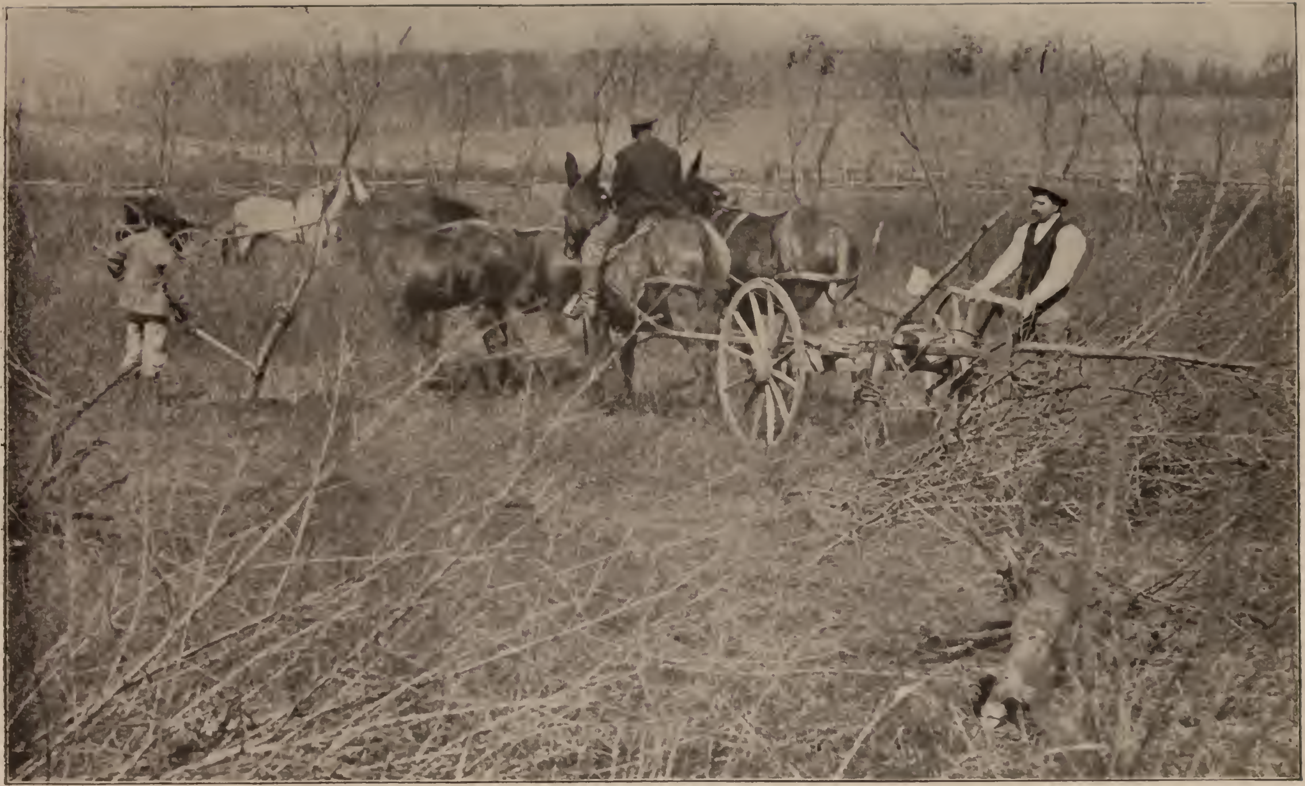

Figure 5.—Removing a peach orchard killed by the San Jose scale. Photo. taken March 8, 1898, by W. G. Johnson

San Jose scale. In reply to Mr. Johnson's letter, I asked whether or not the scale had gained a foothold in his orchard or in his neighborhood, and received the following answer December 2d: "In reply to yours of the 25th instant, would say, that I purchased 50 peach trees this fall a year ago, and planted them in my orchard. The trees did not please me in looks, and having seen specimens of peach infested with the San Jose scale, I made an examination of my trees. I did not have a very good glass for the purpose, but two of the trees were in such a bad condition that I concluded to destroy them. I decided to use whale oil soap on the others, and not knowing whether it would injure them, I wrote you, knowing you could give me the required information.

"I do not suppose there are 500 peach trees within a radius of five miles of my place. This was quite an extensive peach neighborhood several years ago, but on account of the yellows, the trees have been destroyed, and the farmers have ceased planting. In conclusion, I would say, that it was my original intention to have set out 500 trees, but my neighbors advised me not to do it, consequently, I began with only 50, as indicated above."

Burtonsville:—The infested trees at this place are in the orchard of Benjamin Atley, and were purchased two years ago from a New Jersey nursery. Mr. Albert Miles brought twigs to the experiment station for examination February 24th. They were cut from an Idaho pear, and were badly infested with the San Jose scale. Mr. Miles tells me there are about 500 trees in the orchard, but only about a dozen seem to be infested at present. He also stated that a number of his neighbors had purchased trees at the same time and from the same firm. A few days later, Mr. Miles brought pear twigs from other orchards in his vicinity, but I could find no trace of scale upon them.

Sellman:—April 16th, 1898, I received a number of apple twigs from S. D. Mainhart, of this place, infested with scale insects, and upon examination found that one of them was the scurfy scale and the other very badly infested with the San Jose scale. The trees were planted two years ago this spring, and I am informed by Mr. Mainhart, that he has taken out the badly infested ones and burned them. These trees were planted in the vicinity of a peach orchard.

PRINCE GEORGE'S.

Mitchellville:—The outbreak at this place was first recorded by Howard and Marlatt (Bul. No. 3). Mr. Coquillett was detailed to investigate the outbreak December 21st, 1894, and found that the pest had originated upon some Japan plums brought from California. The infested trees were immediately uprooted and burned by the owners. A second inspection was made in November, 1895, by an assistant of the department of agriculture, who found two trees slightly infested, which were immediately destroyed.

I first visited this place August 31st, 1896, and found the scale still present upon Howell, Lawrence, Bartlett and Comice pear. All the infested trees were destroyed by fire. September 3rd, 1896, I found the same scale in a small pear and plum orchard in the immediate vicinity of the place where the other outbreak was discovered. The pest was especially abundant upon a few Garber pear, and from a few plum trees from a southern nursery. All the infested trees were immediately destroyed, and it was suggested that the others should be sprayed with whale oil soap. At the time of my visit to this place October 12th, I found that the entire orchard had been sprayed with soap at the rate of 2½ pounds to a gallon of water. I found, however, that the scale was still present on several Garber pear trees, and suggested that the best method would be to destroy them without delay. This same orchard was again examined March 22d, 1897, at which time I found still other trees badly infested. They were dug up and used for experimental purposes with hydrocyanic acid gas. The same scale was discovered upon Garber and Bartlett pears August 2d, and upon Early Purple Cherry August 3rd, 1897. The pest was also found upon this place on a large number of varieties of pear, plum, apple and other trees, all of which are named at another place in this report. The infested trees, wherever they were found, were either uprooted at the time, or marked, so that they could be located and removed afterwards. In all, about 15,000 trees were found more or less infested, and were destroyed without delay.

August 3rd, 1897, at the request of Mr. Henry McGaw, I visited the extensive orchards of McGaw, Davis & Company, which are located near Mitchellville. These orchards are among the largest in the state, and cover over 300 acres. The first trees were planted in May, 1888, consisting of over 20 varieties, aggregating 9,566 trees. In December, 1889, 4,925 trees of seven different varieties were set out in the same orchard. In November, 1890, 3,700 trees of two varieties were planted, and in April, 1891, 10,120 trees of five varieties were planted, making a total of 28,311 trees in the entire orchard.

After inspecting the trees of various varieties planted at different times, I was horrified when I discovered the San Jose scale in a block of Mountain Rose. These trees were planted in May, 1888, and had made a magnificent growth, and contained some fruit of an inferior quality on account of the peach rot (*Monilia fructigena*), and the attacks of the scale, which caused a peculiar depression in the fruit, giving it a gnarly appearance. The peculiar purplish tinge which accompanies this insect where it attacks a twig or the fruit, was especially conspicuous on these peaches, and the tinge penetrated the fruit to a depth of from one-sixteenth to one-eighth of an inch. From the growth these trees had made, it was apparent at a glance that the pest had not been introduced upon that particular variety. It did not take long, however, to ascertain the source from which the pest had spread, as in a block of 2,200 Wheatland, the scale was everywhere present, and hundreds of the trees were dead and dying from its attack. (See Figures 3 and 4). It was not difficult to locate that particular part of the orchard where the trees were planted which bore the original infestation. The trees which were infested when they came from the nursery had long since died out, and not a vestige of some of them was left, but the growth of the trees surrounding the spots where the first trees had died was very peculiar. For instance, the trees that had been in the immediate vicinity of the infested one had made a very good growth a year or two later, and then succumbed to the attacks of the insect. Adjoining these, other trees had become infested, showing that they had made from four to six years growth before the scale had appeared in destructive numbers upon them. This condition of affairs could be easily traced throughout the orchard in the various blocks where the pest had been introduced.

My letter of August 16th, 1897, addressed to the firm McGaw, Davis & Company, contains some points of general interest in this matter, and I quote it here in full as follows: "Gentlemen:—On August 3rd, at the request of your representative, Mr. Henry M. McGaw, I visited your extensive peach orchard in the vicinity of Mitchellville, Prince George's county, this state, and made a careful examination of the trees.

"I find the San Jose scale has gained a foothold in your orchard, and is responsible to a very large extent, for its present depleted condition. It is not necessary for me to say that this is the most dangerous insect pest that has been introduced into American orchards, as a glance at your orchard in its present condition, would convince the most skeptical that this ravenous pest is a deadly enemy to our deciduous fruit trees. Neither is it necessary for me to enter into a detailed discussion as to the origin of this pest, but will say, that it was unknown to the general public in the eastern United States previous to 1893. It has long been a scourge in the orchards of California, and was accidentally introduced from there on nursery stock in several New Jersey nurseries about 1887, and from them, has been gradually disseminated throughout our eastern orchards and many other nurseries.

"From my careful examination of your orchard on the 3rd and 6th instant, I am led to conclude that the insect, without a doubt, was introduced upon peach trees from the nursery the fall of 1890 or the spring of 1891. The present condition of the orchard reveals the fact that the trouble started originally on the following varieties: Reeves, Geary's Holdon, Smoch, Wheatland, Crawford's Late and Crawford's Early. From these varieties, the insect has spread to others, and in many instances, has killed a large number of the trees. It is quite reasonable to say, that at present there are at least 13,000 trees badly infested, all of which are either dead or dying from the attacks of this insect. From the present condition of affairs, I would advise you to have the orchard dug up and burned as soon as possible, as there is great danger of the insects spreading to various trees, shrubs and other plants in their immediate vicinity, where it would be impossible to exterminate it.

"This outbreak is by far the most serious attack I have ever seen, and for your protection and the protection of others in the vicinity of your orchard, I would advise its destruction as soon as possible. If I can be of further service to you in this matter, do not fail to let me know."

As I have indicated above, this is by far, the most serious outbreak of the scale that has yet come to my notice in this state, and it is to be regretted that it gained a foothold in such an extensive orchard as this one. The orchard was planted with the view of using the product for commercial purposes, and an extensive cannery was erected in the immediate vicinity. I am informed that that part of the orchard planted in 1888-89, has borne only one good crop of peaches. The later plantings have been so reduced by the scale, that few of the trees remaining have borne fruit. Everything possible has been done by the owners of this orchard to make it a profitable one, but in spite of their cultivation, fertilization, etc., the trees have been dying from year to year, and its present condition is due largely to the attacks of the scale. Some of the trees have been injured to a considerable extent by the peach tree borer. There is also an indication that the trees in some parts of the orchard have suffered from severe cold weather. On the whole, the trees were in such miserable condition, it seemed useless to try to restore them, so that they would in the future, be of any value whatever.

I took several photographs of this orchard from various positions August 6th, and reproduce two of them as Figures 3 and 4. These views were taken in a block of 2,200 Wheatland, planted in April, 1891, and give a very graphic idea of the present condition of the orchard in mid-summer. The views look more like mid-winter than mid-summer scenes, when the trees should be in full foliage. It is not possible for me in this place to describe in detail all the minor particulars regarding this infested district. Suffice it to say that the owners have left nothing undone on their part to eradicate this deadly enemy.

In reply to a recent query regarding this orchard, Mr. Geo. K. McGaw writes me December 20th, as follows: "It is our intention, and we are now at work on its execution, to destroy the entire peach orchard, consisting of something over 28,000 trees."

In conversation with Mr. McGaw December 17th, he told me that twenty-five thousand dollars cash would not compensate him for the loss he had sustained from the attacks of this ravenous pest in his orchard, to say nothing of the loss of the use of the 300 acres of land for nearly eight years.

I visited these orchards March 8th, 1898, and found a force of men at work grubbing and pulling up the trees. About 10,000 had been uprooted and the whole place was a scene of desolation. Nothing but stumps, roots and piles of brush as far as one could see. A fair idea of the method employed in removing the trees, and the general appearance of the orchard can be gained from figures 5 and 6.

March 8th, 1898, I found the scale was just beginning its establishment in a twelve-year old peach orchard, belonging to Mr. Peach near Mr. McGaw's place. The trees are badly shaped, but have made a very good growth, and are well set with fruit spurs. The scales are noticeable on the young fresh growth.

There is also another old orchard in the vicinity of Mitchellville, into which this scale has gained a foothold. The orchard contained very few living trees, and none of them were of any special value. It was suggested that all the trees be grubbed up and destroyed, and I am informed that this suggestion has been carried out. Was at this place March 8th, 1898, and find all the trees have been destroyed.

T. B. Post Office:—The infestation at this place was brought to the attention of Dr. Howard in August, 1895, by Mrs. E. L. Nixon. In all, there were about twenty trees found badly infested, some of them having died. They were planted in the spring of 1891, and made little growth.

To a recent inquiry as to the condition of this orchard, Mr. Nixon writes December 8th, as follows: "The scale has simply taken our orch-

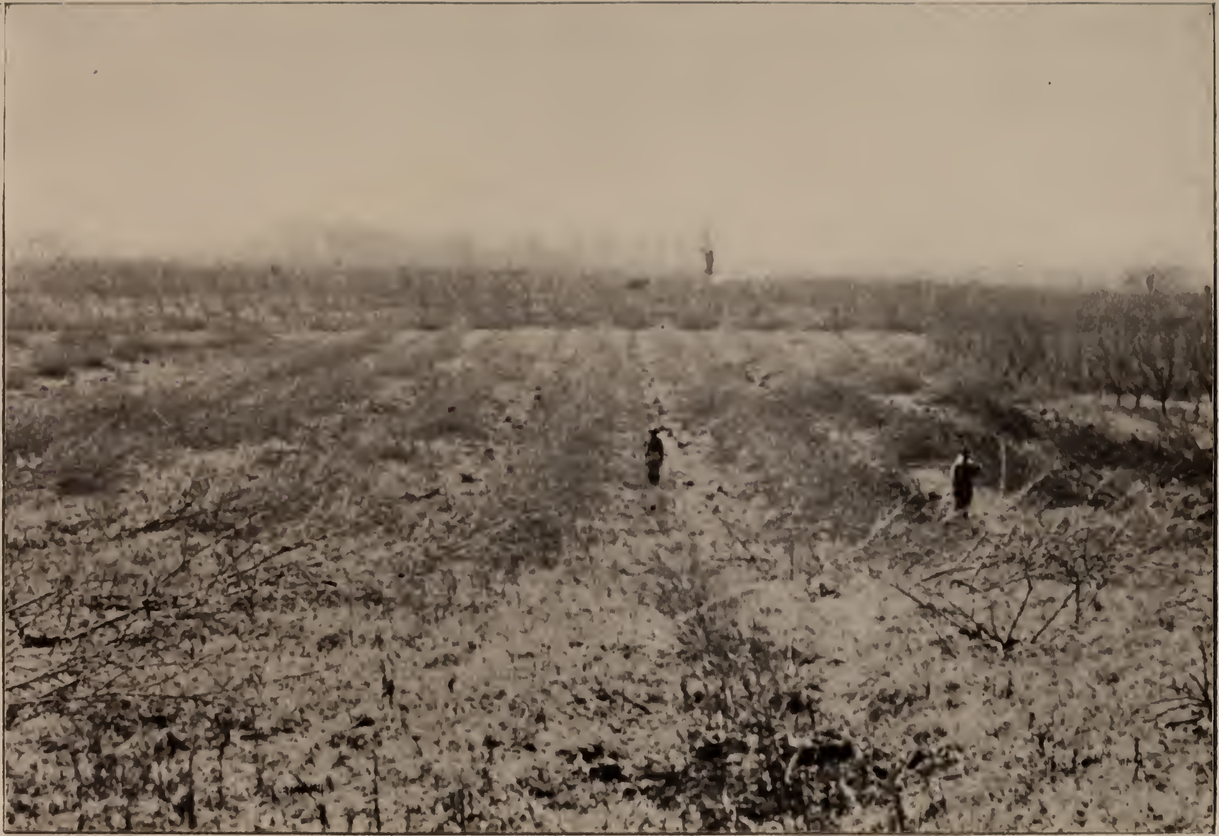

Figure 6.—Cutting down a peach orchard destroyed by the San Jose scale. Photo. taken March 8, 1898, by W. G. Johnson.

ard of 450 trees, which was just coming into bearing. It has spread to our Japan plum trees now, and I presume will kill them next. The most of the peach trees are dead, and we shall cut and burn the entire lot. The trees were purchased six years ago last spring, and had the scale upon them at that time, but we did not know what it was until about two years ago."

Berwyn:—The scale at this place was found by Mr. F. C. Pratt upon a single plum tree in January, 1896, on the premises of Mr. J. C. Brelsford. So far as observations went at that time, it was not detected on any of the adjoining trees. The original tree was dug up and taken to the U. S. Department of Agriculture for experimental purposes.

A recent examination of the trees on this place by my assistant, Mr. Sherman, shows that the pest is still present upon several trees. Mr. Brelsford informs me that he will wash all the trees with whale oil soap before spring. Mr. Sherman was unable to find the scale upon trees in any of the adjoining premises.

QUEEN ANNE.

Centerville: In a communication from R. S. Emory April 17th, 1898, I was informed that his brother, Frank, of this place, who had been in Baltimore at the horticultural convention and listened to the proceedings, had examined the trees in his orchard upon his return home, and found the San Jose scale upon trees he had purchased from a New Jersey nursery several years ago.

Specimen twigs were sent to Capt. Emory for examination. Upon receipt of this information, I immediately wrote to Mr. Emory at Centerville, asking for definite information regarding the outbreak, and found that he had purchased 400 Bartlett pear trees in 1889, from a New Jersey nursery. He says they were a miserable lot of trees when received, and he hesitated before planting them. The trees have never been healthy, and few of them have been dying year after year. He informed me that since he had learned definitely that it was San Jose scale upon them, he ordered the entire lot taken up and burned.

SOMERSET.

My attention was first called to this outbreak January 20th, 1897, by Mr. E. E. Matthews, who resides in Somerset county, near Pocomoke city. He wrote to the Agricultural College, asking for information about the San Jose scale, as he was of the opinion that he had it upon trees in his orchard. Upon receipt of this information, I wrote Mr. Matthews, asking for specimen twigs for examination, and received a reply, together with the twigs, February 6th. As was suspected, the twigs were very badly infested with the San Jose scale, and further inquiry revealed the fact that the trees came originally from a New Jersey nursery seven or eight years ago, and that most of the apple and pear trees bought at that time have since died. The pest has spread to other trees in the immediate vicinity, and has seriously checked their growth. I am informed that many of the infested trees have been dug up and destroyed, and everything possible will be done to check the further spread of the pest in that neighborhood.

I visited Mr. Matthews' place January 14th, 1898, and made an examination of his trees. I find the scale has spread to a very great extent throughout his orchard, and many peach trees have been killed by it. About 500 trees have been taken up and burned. I find a number of pear and almond trees have also been destroyed by the pest. It is present upon a large number of pear, apple and peach trees. I also found it had gotten into an old peach orchard some distance away from the trees originally infested.

I was much pleased to see the great number of varieties of fruits and nuts Mr. Matthews had on his place, and it is to be regretted that the San Jose scale has gained a foothold in so promising an orchard. Nothing will be left undone to check its spread.

TALBOT.

Neavitt:—The first outbreak in this county was recorded by Howard and Marlatt (Bul. No. 3), and was brought to their attention May 19th, 1894. The orchard consists of about 14 acres belonging to Mr. J. H. Reip, and is situated on an inlet of the Chesapeake Bay. The orchard consists mostly of peach trees, with about four acres of apple, cherry, plum and pear trees. The age of the trees range from one to eight years, and practically all of them were infested. There is little or no doubt but what the pest was introduced at the time the stock was purchased, but the source of the infestation is uncertain, as the trees came from several different nurseries.

In reply to a recent letter of inquiry regarding the present condition of this orchard, Mr. James D. Haddaway says: "At the request of Mr. J. Henry Reip, whose orchard I am looking after, I herewith give you a short account of how I have been fighting the San Jose scale for the last three or four years. I discovered something was wrong with some of our trees in the spring of 1894, and not knowing what the trouble was, I sent cuttings to the U. S. Department of Agriculture for examination, and soon received information that the trees were badly infested with the San Jose scale. Mr. D. W. Coquillett, an assistant of the division of entomology, came and made a thorough examination of the trees. At that time, we had about fifteen hundred peach trees, about four years old, so badly infested that more than one-half of them were destroyed. We also had four of five acres in young apple, pear, and cherry trees, which were also infested, but not so badly as the peach trees. On these trees, I have been working to destroy the insects. While I have not succeeded as I could wish, I am satisfied that the extermination of the pest can be accomplished, if every person having an infested tree would either destroy it, or apply some remedy for the destruction of the scale, and it seems to me almost useless, unless this is done. Spraying with kerosene emulsion is the remedy I would recommend as being the best I have ever tried, and any time after the trees shed their foliage the best time to apply it."

Easton:—Specimens of this pest were sent to the experiment station by Mr. A. H. Larrimore, October 9th, 1896, who took them from trees on the premises of Mr. Fred. Thom, about two miles north of Easton. I visited this place in company with Mr. Larrimore November

18th, and found the trees very badly infested. The orchard was a small one, consisting of fifteen peach, six apple, and a few other trees in the immediate vicinity. The scale was present upon all of them, but was especially abundant on the apple, several of which had died from its attacks. It had also spread to a number of ornamental shrubs planted in the dooryard. An examination of a few peach trees some little distance from Mr. Thom's place showed that the scale had also gained a foothold upon them, but had done no special injury up to that time. Upon inquiry I found that the trees had been purchased originally by Mr. August Hemmerle about four years ago from a Philadelphia nurseryman.

I went to Mr. Himmerle's place, but was unable to find any indication of the scale in his orchard. He informed me that some of the trees had died prematurely, but he was not sure that they had died from the attacks of the scale. A careful examination of the trees in the immediate vicinity of those that had died showed that the scale had not gained a foothold upon them, and I am therefore of the opinion that the pest was introduced only on the trees which were sold to Mr. Thom. Mr. Thom was advised to destroy the badly infested trees and treat the others with whale oil soap.

WASHINGTON.

Sharpsburg:—Mr. Joseph H. Cox, of this place sent specimens of diseased peach twigs to the experiment station for examination the fall of 1894. These twigs were submitted by Prof. Robinson to Dr. Howard, of the U. S. Department of Agriculture for determination, December 2d. This orchard is situated about three miles north-west of Sharpsburg, on the Potomac river, and there is no doubt but what the scale was introduced upon a certain variety of trees at the time they were purchased from the nursery.

In reply to recent inquiry regarding the present condition of this orchard, Mr. Cox says, under the date of November 27th:—"Mr. Coquillett examined my orchard in March, 1895, as you stated in yours of the 23rd instant, and he ordered about 40 trees taken out, suggesting that the other infested trees should be sprayed with whale oil soap at the rate of two pounds to a gallon of water, which made it very strong. There were about 1,000 trees in the orchard, planted in 1891, and I sprayed them with soap as directed. I thought I had conquered the pest until the fall of '95 and the spring of '96, when I noticed it on the trees worse than before. I then sprayed them again with soap, using the same quantity to the gallon of water as before, but it did not destroy them, as they got worse instead of better. Last winter I pulled the trees up and burned them, root and branch, and raised a crop of corn in that field this season.

"I have an idea for the destruction of this pest which I desire to give you, and hereafter if I have any bother with that pesky creature I will try it. My plan would be to saw the tops out of the trees, and then singe the trunks and larger branches with a torch. I am of the opinion that it would not injure the tree while in a dormant state. Let me hear from you about this idea."

Mr. Charles G. Biggs, of Sharpsburg, wrote Dr. Howard, November 30th, 1895, that the scale had made its appearance in the orchard of

Biggs & Showman, three miles south of Sharpsburg. By request, Mr. Coquillett visited the locality January 30th, 1896, and made an examination of the infested trees. He found that the pest had been introduced upon peach trees, and had spread to a considerable extent throughout the orchard, as about a thousand trees had already contained the scale. A number of the badly infested trees had been dug up and burned. It was suggested that the moderately infested trees be sprayed with whale oil soap without delay, and I am informed by Mr. Biggs that the material was applied as carefully as possible. Mr. Biggs had been very energetic in his warfare against this pest, and has left nothing undone to check its spread in his extensive orchards. He was one of the first to see the very great danger of the destruction of the orchards by this insect, and in 1896, appeared several times before the legislative committees in behalf of remedial legislation.

In reply to my recent letter, making inquiry about the present condition of his orchard, Mr. Biggs writes, November 26th, as follows: "Three years ago, I discovered the San Jose scale in our, that is, Biggs and Showman's orchard. We immediately applied whale oil soap in the proportion of two and one-half pounds to the gallon of water, and I thought we had the pest under control, but this year it has again appeared on about three or four hundred trees, though not in as great quantities as before, showing the impossibility of reaching all the scale by spraying, no matter how carefully the application is made. We are now topping all the badly infested trees, destroying the excised branches and thoroughly washing the portions left standing with a strong solution of the soap. If we fail to eradicate it this time, we will top all infested trees and treat the stumps, which will form new, healthy heads in two years. Our orchard is three miles south of town, on the mountain."

By appointment. I visited Mr. Biggs' orchard January 21st, 1898. Mr. S. S. Stouffer, of Sharpsburg, Professor F. M. Webster, the entomologist of the Ohio Agricultural Experiment Station, who was my guest, and Mr. Biggs, accompanied me to the orchard. We found a very bad state of affairs. Instead of finding between three and four hundred trees infested, as we expected, we found between three and four thousand. Many trees here and there on the lower side of the orchard were literally covered with the pest, and it had pretty generally distributed itself throughout a block of about four thousand trees up the side of the mountain in the direction of the prevailing winds. It was one of the most striking examples of the spread of this insect by the wind that I have ever seen. Between four and five hundred trees have been cut down and burned, while many others have been cut back to the stumps and treated with whale oil soap. I have advised the cutting out and destruction of all the badly infested trees, the immediate pruning of all slightly infested ones and their thorough spraying with whale oil soap. The spraying to be repeated again in the spring, and a third time next fall.

Mr. Biggs called my attention to another outbreak of the scale in the vicinity of Sharpsburg, on the place of Mr. Samuel H. Neikirk. Part of the orchard has been cut down and destroyed this fall. In reply to a recent letter of inquiry, Mr. Neikirk says, under date of December 10th:

"My reply to your inquiry has been delayed from the fact that I desired more definite information about the original source of my trees. I bought 3,500 peach, a few apple and cherry trees in the spring of 1891, from a local dealer of Hagerstown, who has since discontinued the nursery business. He purchased his peach trees from a Virginia nursery. I believe my peach trees were infested when I got them, although I did not notice anything wrong at first; but in a few years their condition clearly indicated that they were not heathful.

"I discovered the real cause of the decay of my orchard this spring, and could hardly believe it. A number of fruit buyers were in my orchard this spring, but none of them knew what was the matter with the trees. About 2,000 trees were infested, and many of them were killed this season with fruit hanging on the twigs. Most of them had one or two limbs badly infested which were dead, and the rest of the tree literally covered with insects. It took me but a very short time to conclude that the sooner they were all reduced to ashes the better."

I visited Mr. Neikirk's place January 21st, 1898, and inspected this orchard, as well as another in the immediate vicinity. Mr. Stouffer, Mr. E. A. Pry, and Mr. Neikirk's two brothers accompanied me. I found about two thousand peach trees had been cut down, and the stumps and many piles of brush remaining on the ground. There were about twenty-three hundred trees still standing in the orchard, and I found the scale more or less abundant wherever I went. It does not seem advisable to try to save any of the trees, they are in a frightful condition, and it will be economy to destroy them at once. Last spring Mr. Neikirk set out several hundred plum trees and I find the scale has established itself upon them. They were planted along side of the badly infested block of peach. He also has a lot of peach trees heeled in, which he has intended to plant in the same orchard this spring, but I have strongly urged him not to do it.

Still another infested orchard near Sharpsburg was brought to my attention by Mr. Neikirk in his letter of December 10th. It is on the place of Mr. James Snyder and adjoins Mr. Neikirk's orchard. I made an examination of this orchard also, January 21st, 1898, and found the trees in very bad condition. The most of them were dead. About nine hundred trees adjoining Mr. Neikirk's orchard had been dug up and the ground planted in wheat last fall. The remaining two thousand trees were in such a frightful condition, nothing can be done to save the few hundred that still remain alive. From the indications, it seems quite likely that the pest came into Mr. Neikirk's orchard from Mr. Snyder's, and I am inclined to hold to this opinion until I get further facts bearing on the infestation. In reply to my letter of March 26th, 1898, Mr. Snyder informs me March 27th, 1898, that the orchard has been cut down; but I found upon personal inspection, that a few trees only had been destroyed, and that between 1,400 and 1,500 trees are still standing, which I have since had destroyed.

Shockey's Station:—Mr. C. W. Reichard, of Hagerstown, informed me February 3rd, 1897, that he had the San Jose scale in his orchard, which is located about two miles from Edgemont, near Shockey's station. He said the trees were originally purchased from a local nurseryman, Mr. W. S. Reichard, who has since gone out of business. In a letter dated December 2d, 1897, Mr. C. W. Reichard says: "Replying to your communication of the 30th ultimo, would say, that in the fall of 1892, I planted about three hundred pear trees in an orchard where there had already been set 125 pear. In the fall of 1895, I discovered several trees, planted 1892, diseased, and during the winter established the fact that they were affected with San Jose scale. In the spring of 1896, all diseased trees that I discovered—to the number of six or eight, were dug up and burned; these were Bartletts. I soon discovered that quite a number of Bartlett and Duchess were more or less affected. In November of 1896, I sprayed the orchard thoroughly with whale oil soap. During the early part of the summer of 1897, I could not discover any of the scale, but at present writing find a few scattered on trees in different parts of the orchard.

"From my observation and experience I am satisfied that whale oil soap is death to the scale when it gets on them properly. The trouble is to reach all the pests with a spray."

Regarding the source of these trees, Mr. W. S. Reichard writes me December 15th, 1897, as follows: "As to Mr. C. W. Reichard's trees, I do not know positively where they came from. I was not raising any pear at that time, and he bought them, I think some place near Rochester, N. Y."

Brownsville:—Mr. J. P. Blessing, of this place, sent specimen twigs cut from trees in his orchard infested with the San Jose scale to the station for examination March 11th. 1897. He says: "I got the scale into my orchard on pear trees, and have fought them for three years with kerosene emulsion, potash, etc. The most effective wash I ever applied was bichloride of mercury, but it is too dangerous a poison to use as a spray. I have kept the scale in check, but have not exterminated it."

The condition of the orchard at present is told in a letter received from Mr. Blessing, December 2d, and is as follows: "Replying to your favor of the 30th ultimo, would state, that the San Jose scale was introduced into my orchard upon pear nursery stock. From the pear trees, the scale spread to an adjacent peach orchard containing 6,000 trees. Some 50 or more trees were completely incrusted with scale in the course of one season, and 200 more trees were infested; all of which I pulled up and burned; but outside of the trees destroyed were a considerable number of scale-infested trees. Last fall I gave these trees a spraying with kerosene emulsion. In December, I had a carload of air-slacked lime thrown among the branches while the trees were damp, which adhered to the trees for weeks. This was followed this spring by a spray of whale oil soap, applied as hot as could be handled. All of these applications reduced the scale, the whale oil soap being the most efficient. But in spite of all my efforts to exterminate this terrible foe, I would never have succeeded but for an invasion of lady bugs. I found them everywhere in my orchard during July, August and September. I made diligent search during October and November for live scale, but failed to find a single one. I think it was six years ago that I planted the scale-infested pear trees. Most of my peach trees had been planted two years before."

Cavetown:—The infestation at this place is in the orchard of Messrs. John and Jacob Hoffman, and was inspected by me October 8th, 1897. As nearly as I can ascertain, the trees were purchased in the fall of 1891 or 1892. The orchard is a small one, containing not over 500 trees, and the most of them have made a beautiful growth. Many of the trees this year have shown signs of decay from the attacks of the San Jose scale. It was not difficult to locate the trees in the orchard where the original infestation occurred. The pest seems to have been introduced upon a few trees, which have since died, and spread the contagion to others in the immediate vicinity. There were about 50 trees in the vicinity of those that had died out from the attacks of the scale. They were literally covered with the pest from top to bottom, and it was almost impossible to see the bark at any point. Mr. Hoffman had seen the sickly condition of these trees and had gone into the orchard the evening previous to my visit and had cut off the branches of the badly infested trees, leaving only the trunks standing. The scale had spread throughout the entire orchard, and was found at the opposite end on a small apple seedling that had come up one year ago. The whole orchard was so generally infested I advised its destruction, and I have since been informed that it has been destroyed.

I also found the scale upon young peach trees in a large orchard on the opposite side of the road, which was planted last spring, belonging to Mr. Diffendal. A careful examination of these trees showed that three-fourths of them on the first three or four rows adjoining the Hoffman orchard were slightly infested. The same pest was also found in an old orchard nearby belonging to Mr. Davis. Many trees in this orchard were dead and dying from the attacks of the yellows, and the place had been somewhat neglected. Both Mr. Davis and Mr. Diffendal were informed that the scale had gained a foothold in their orchards, and were advised to take immediate steps to check its further spread.

There is little doubt but what the pest was introduced into the Hoffman orchard at the time they were purchased from the nursery, and has generally spread to other trees in the same orchard, and from there to the other places mentioned above.

Smithburg:—The attack at this place is in a large peach orchard on the side of a mountain, and the pest seems to have originated on a few plum trees purchased about three years ago and set out in the orchard between the peach trees. The plum trees have since died, and other trees have been set out where they stood. From a general inspection of the orchard it appears that the pest has as yet confined its attacks to about 25 trees in the immediate vicinity of the place where the plums were planted. These trees are only moderately infested. At the time of my examination, October 7th and 8th, I found about 200 Ben Davis apple trees in the same orchard were slightly infested. It was suggested that the infested ones should be destroyed, and all other suspicious trees in the same block should be either fumigated with hydrocyanic gas or sprayed with whale oil soap.

Edgemont:—October 4th, 1897, I received a specimen pear from Mr. Samuel B. Loose, of Hagerstown, who stated that it had been taken from his orchard near Edgemont. He was apprehensive that the condition of the pear was due to the attacks of the San Jose scale, and sent the specimen for examination. I wrote him immediately that the creature was the genuine San Jose scale. I stated also that I expected to be in the vicinity of his place in a few days, and I would call upon him and make an examination of his orchard. I examined the orchard October 7th, and found the scales upon some pear trees that had been planted some four or five years. The trees had not made a very good growth, and several of them were literally covered by the scale. Mr. Loose first discovered it on some fruit he was packing, and suspecting what it was, sent me the specimen for examination. I found the pest had spread to possibly 50 or more trees in the orchard, and the trees upon which it was originally introduced, had been dead for some time. Mr. Loose does not know from whom the trees were purchased, as he has but recently bought the farm. I was unable to find the scale in an adjoining quince orchard, and am of the opinion that it has confined its attacks to the pear. Mr. Loose assured me that he would leave nothing undone on his part to check and destroy the insect in this orchard.

Trego:—While attending the meeting of the Horticultural Association of Western Maryland, at Hagerstown, January 22d, 1898, Mr. D. D. Keedy handed me a small twig cut from a plum tree on the premises of Mr. H. C. Rohrer, and asked me to examine it. At first glance, I saw that it was badly infested with San Jose scale. Upon inquiry, I found that only one tree, so far as determined at present, was infested. It was purchased from a local dealer two years last fall. My advice was to dig up and destroy the tree as soon as possible, and treat all suspicious ones with whale oil soap before the buds open. In reply to my letter of inquiry, Mr. Rohrer writes me that he had only fifty trees in all, and so far, he can see only one infested.

Boonsboro:—March 15th, 1898, I receievd a specimen twig cut from an apple tree by Caleb Long, of this place, stating that in his judgment the twig was not infested with the San Jose scale, but some other species. Upon examination, however, I found that the insect was the genuine San Jose scale. Fortunately for Mr. Long, this apple orchard only contains 50 trees and only two of them were found infested with the scale. The trees were purchased from a Pennsylvania nurseryman, and nothing will be left undone on Mr. Long's part to completely control and suppress the insect in his orchard. He says: "I apply the sure remedy, the ax."

GENERAL RESULTS AND PROBABLE OUTCOME.

From the foregoing facts, it is evident that the scale is very generally distributed, and it will be some time before it ever can be exterminated in this state. The only places where extermination has actually been accomplished, are in orchards and nurseries where all the trees have been uprooted and burned. It is hard to realize what havoc this deadly pest has occasioned in the orchards of this state, even after considering what has already been said; but by summing up the situation in figures, the magnitude of the attack is apparent.

The 95 infested orchards contain 157,165 bearing trees, of which

58,620 were infested, and 50,343 of these have been killed from the attacks of the scale during the past four or five years, and have been dug up and burned. This leaves still standing 8,277 infested trees in the midst of 106,822 bearing trees in their prime. Aside from the above, 21,577 nursery trees have been destroyed, making a total of 71,920. The actual loss in dollars, of course, cannot be determined, but figuring the cash value on taxable basis, the owners of these trees have lost $68,897.00, to say nothing of the loss of land, labor, crops, etc. The losses to individuals vary from a few dollars up to the enormous sum of $25,000.00. In several instances, the orchards have been completely swept out of existence in a few years, and the cause was not ascertained, until the work of the deadly enemy was completed.

In view of all these facts, one might say, that the outlook for the future orchardist was very discouraging. Indeed it is, but this pest need not run fruit growers out of business. If we continue our inspection and fumigation work in the nurseries, we can soon control the principal source of danger. It remains, therefore, for the grower to be more alert himself, and when a tree dies, if the cause is not apparent, it should be ascertained if possible, without delay. In a great many cases in this state, the orchardists knew their trees were not thrifty and healthy, and that many of them were dying in spite of the most careful tilling, pruning and fertilizing. When this condition confronted them, they should have sought expert investigation, which was at their command, simply for the asking. Such negligence is excusable the first time very often; but a man does not usually lose a second 1,500 or 2,000 trees before he knows what the difficulty is.

By prompt action, backed by state legislation, I am confident we will successfully control the San Jose scale in this state, if we apply intelligently the remedies that have already been tested, and found effective. To succeed, we must locate all infested orchards, control the nurseries, and insist upon a written guarantee by a qualified officer with nursery stock, as well as inspect and watch the trees after they are set out. We are now enforcing this system in this state, and we have the scale now reduced to a minimum, so that there is no danger of its future spread.

NATURE OF ATTACK AND GENERAL APPEARANCE.

On badly infested trees, the San Jose scale attacks the leaves as well as the trunk, branches and fruit. It is a very common thing to find trees covered with the scale to such an extent that it is not possible to see the bark at any point upon the trunk and larger branches. In such instances, the trees usually have a grayish or ashy appearance. This is due to the coating of the delicate little shell-like scales which have become somewhat bleached by the weather. Normally, the scales are almost black when half grown, but become lighter as the insect matures, and when a tree becomes coated with them, it has the grayish or ashy appearance described above. One can easily scrape off the scales with the thumb nail, providing the tree is still alive, in which case there will be an oily substance caused by the crushing of the insects under the scales. If, on the other hand, the tree is dead, the scales are not so easily detached, and the oiliness is absent from the fact that all the insects are dead and dried up.

The real appearance of the scale cannot be detected by the average eye sight, without the aid of a magnifying glass. If an infested twig is examined with a hand lens, it will be seen that it is coated with shell-like objects, varying in size, shape and color. It resembles very much a stick covered with barnacles. If the examination is made in the summer time, the young, yellowish lice would be seen crawling about and over the scales, as shown in the illustration at figure 7.

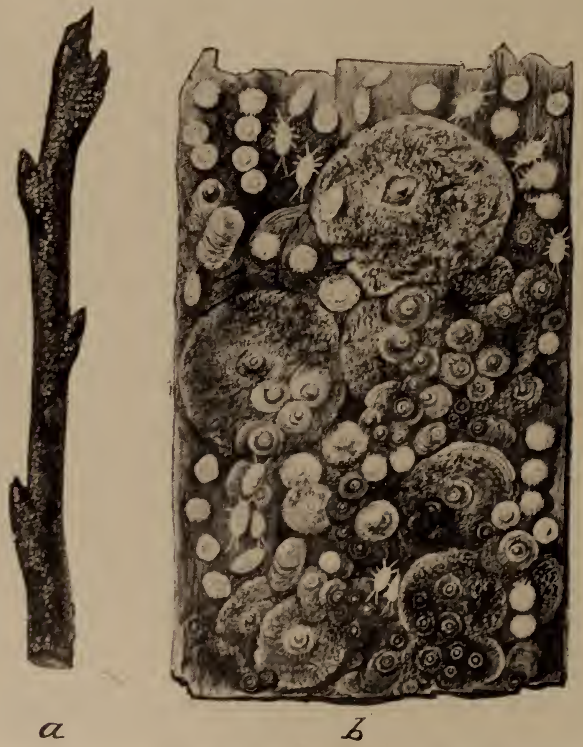

Figure 7.—Appearance of San Jose Scale on bark; *a*, infested twig, natural size; *b*, bark as it appears under hand lens, showing scales in various stages of development and young larvæ. (After Howard and Marlatt in Bulletin 3, n. s. Div. Ent. Dept. Agr.)

The nature of the attack varies considerably, and depends upon the kind of tree. Peach, in my experience and observations, is the most susceptible of all the fruit trees. It is a very rare occurrence in this state to find an infested peach tree that has withstood the attacks of this insect three years, and the size of the tree up to the age of five or six years has little to do with it. Trees six years old which have made a beautiful growth, succumb readily to this deadly enemy. An excellent illustration of this character can be seen by referring to figures 3 and 4. Where peach trees from four to six years old become encrusted with the scale, all the upper branches will be completely killed, and new growth will begin from the main trunk near the ground. Trees in this condition with the cluster of sprouts at the base, with leaves very much larger than the normal leaf, present a very characteristic appearance. The dead tops set in a bunch of green foliage, is very striking, and the cause of the condition can be inferred, as far as one can see the tree. In one peach orchard of 2,500 trees five and six years old, 1,300 were in this condition last fall. In another orchard, containing something over 28,000 peach trees, about 8,000 had this peculiar growth. This condition is, no doubt, due to the fact that the root system of larger trees is sufficient to maintain life in the lower part of the trunk, even after the top has been entirely killed. The young growth is usually pitted, and marked by the presence of the insects the first season, and rarely, if ever, lives through the second season. It is therefore, not an uncommon occurrence to find trees in an orchard entirely dead where this growth at the base was conspicuous the year previous.

Young peach trees from two to three years from the bud are not usually affected in this way. When attacked by the scale, they are killed out completely, there not being enough root system to sustain the growth at the base. I never have seen, and have not heard of an instance where a peach tree was killed by this scale in the nursery row. This is what we would expect, as the bud produces a marketable tree by one season's growth, and if the scale has been introduced on the bud, its presence would only be susceptible late in the season. The second and third years, therefore, in the life of a peach tree, if the scale was introduced when budded, are the important ones.

Pear, apple, plum, quince, cherry, apricot and nectarine are not so quickly killed as the peach, but all of them will finally succumb, if the scale is allowed to breed year after year uninterruptedly. Pear, Apple, plum and cherry will usually die the third or fourth year, providing the pest is upon the trees at the time they come from the nursery. I have seen cases where pear and apple have been killed in one year from the nursery, and it is not an infrequent occurrence to find dead pear, apple, plum, cherry, apricot and nectarine in a nursery row, where the scale has been established. The general appearance of badly infested trees is about the same in all cases, the scurfy, grayish or ashy coating being conspicuous.

If a pear tree is moderately infested, the scales are easily detected at the very tip of the new growth. They do not occur so conspicuously on the terminal growth of the apple and plum, as on the previous years's growth. The pest is seen on the leaves usually only on badly infested trees. On peach, it produces a reddish or purplish tinge on the leaf, especially where the insect is attached. There is at times, a yellowish spotting that follows the attack. As a rule, the great majority of the scales are attached to the upper surface of the leaf, and arranged along the mid rib and veins, and are mostly males. Pear and apple leaves are not so conspicuously marked as peach.

I have seen the scale only on the fruit of apple, pear and peach. Where there are only a few insects upon a pear or apple tree, their presence upon the fruit affords the easiest and simplest method of locating the infested trees. The bright reddish or purplish spots produced by the inects are very conspicuous, and can be seen with the naked eye long distances. On badly infested trees, the fruit becomes one mass of spots and scales; it is small, rough, and sometimes cracked open, as seen at figure 8. Such fruit is not fit for the market, as it is incipid, and should be avoided. The scale also colors the peach somewhat in a similar manner, but the spots are not, as a rule, so conspicuous, on account of the fuzzy surface. By cutting into an infested peach, it will be seen in some varieties that the purplish tinge extends to a depth sometimes of a quarter of an inch.

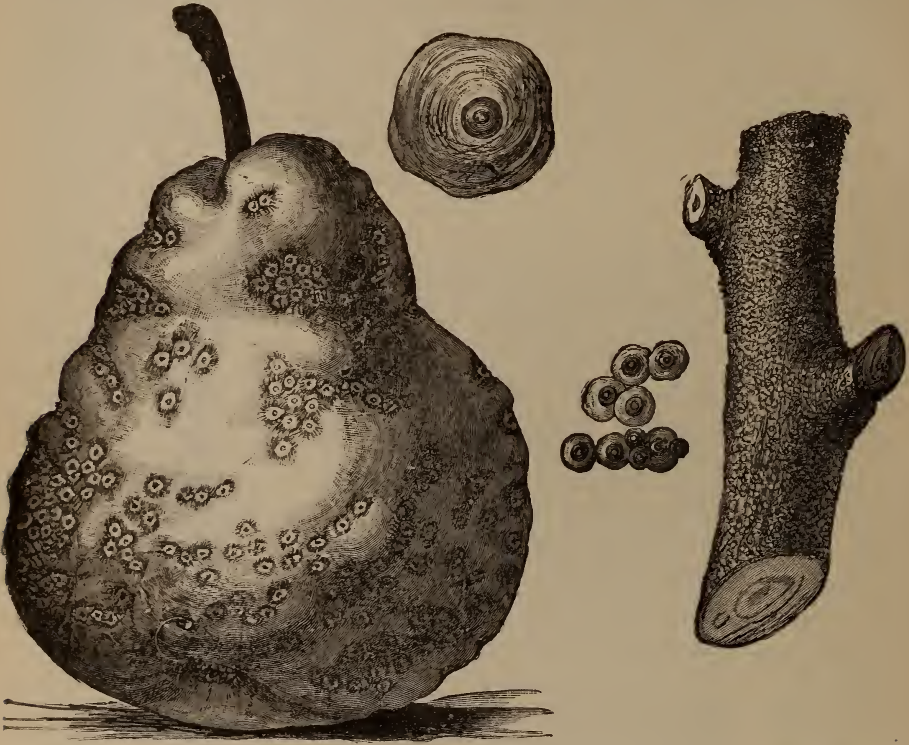

Figure 8.—San Jose scale on twig and pear, with enlarged male and female scales. (After Howard, Year-book Dept. Agr. 1894.)

I do not know that the scale has ever been found upon the roots of a tree in their normal position and covered. The inference is, that it cannot thrive below the surface of the ground where the earth is closely packed around the tree. It has been found below the surface around the trunk of young tress where there was more or less open space, caused by the swaying of the tree, or where burrows had been made by ants. In fact, it seems very probable that ants may have considerable to do with the establishment of this scale upon certain trees. Prof. Webster cites an instance of this nature in Entomological News (December, 1897), in which he says:

"For my own part, I have become exceedingly suspicious of the influence of ants scattering the San Jose scale, not only about the ground, but below the surface as well. We have one case in Ohio, where a young orchard was set out in 1893, and in the fall of 1895, an infested tree was found and cut off six to eight inches below the surface of the ground, and burned. In cultivating, dirt was thrown toward the place where the tree had stood, and in the meantime, a young shoot had started up from the old stump, and grown to a considerable height. This fall, this shoot was found to be badly infested with the scale, and only a few were on the trees next adjoining."

The conspicuous purplish spots produced by the scale on certain varieties of trees, are valuable characters, and aid the inspector very much. It cannot be inferred, however, that the insect observed, is the San Jose scale, simply because the purplish spots are present. The cherry scale, *Aspidiotus forbesi,* a species described by me from Illinois a few years ago, and Putnam's scale, *A. ancylus,* both produce markings of the same character; and it is not uncommon to find markings of a similar nature on pear, produced by the scurfy scale, *Chionaspis furfurus.*

FOOD PLANTS.

The San Jose scale has a very wide range of food plants, attacking practically all of our deciduous fruit trees, and many of the small fruits. It can also sustain itself upon many of our ornamental shrubs and native trees. In two instances, I have found it breeding during the summer months upon crab grass and milk weed, in the vicinity of infested trees.

The following list of food plants has been made up from original observations, and a careful review of all recently published articles on this subject. At present, we have recorded forty-six species of plants upon which the scale has been found, to say nothing of the large number of varieties embodied. For instance, under apple, I have observed the pest upon no less than 80 varieties during my inspection work in nurseries and orchards.

Of the orchard fruits infested, the peach, pear, apple, plum and cherry are most conspicuous in this state, but the quince, persimmon, Rocky Mountain dwarf cherry and flowering quince should be included.

The small fruits are currant, grape, raspberry, gooseberry, flowering currant, black currant and strawberry. The nuts are pecan, almond, chestnut, black walnut, Japan walnut, and English walnut. The miscellaneous trees, shrubs and other plants are linden, elm, acacia, alder, osage orange, sumac, weeping willow, English willow, golden willow. laurel leaved willow, catalpa, Lombardy poplar, Carolina poplar, golden leafed poplar, silver maple, cut-leaved birch, mountain ash, Japanese quince, Citrus trifoliata, Actinida, red dogwood, snow ball, June berry, Loquat, Laurel, Akebia, Vose spirea, Cotoneaster, hawthorn, euonymus, English huckelberry, milkweed and crab grass.

From this wide range of plants, it appears that the scale can accomodate itself under most any circumstances, and doubtless, other food plants will be discovered. There are certain groups, however, upon which it has not been found, the pines and cedars for example, appear to be exempt. There are certain varieties of fruits also that seem to be practically free from its attacks, as noted in this report. The Kieffer and Laconte pear, although standing along by the side of badly infested trees, were practically free. There was also another instance of this kind near Still Pond, Kent Co., where the infested trees were entirely surrounded by a block of Kieffer pears. The infested trees were all destroyed when the real character of the insect was discovered, but up to the present time, no scales have been found in the Kieffer orchard. Still another evidence of this character was found in the orchards of John I. Case, near Wheaton, Montgomery County. Here a number of Kieffer pears were planted in between badly infested peach trees, and in no instance, could more than a dozen scales, and these mostly males, be found after diligent searching. Howard and Marlatt cite a peculiar case of this nature in their Bulletin (No. 3, n. s., p. 38), in which they say: " A notable instance is the case of a tree which bore both Lawson and Kieffer grafts. The Lawson branch leaves and fruit were entirely covered, while the Kieffer portion was entirely free from the scale."

Prof. Webster has observed that the Early Richmond cherry was also practically immune. He says (Bul. 81, p. 212): "I have seen a case where the limbs of one of these cherry trees interlocked with those of a pear tree, that had been killed by the scale, yet the cherry was free. In another case, an early Richmond tree had been grafted into Mahaleb stock, and a shoot of the original stock had been thrown from out below the graft. This shoot was thickly populated with scale, while the tree itself was entirely free. I have never yet found it attacking Mulberry, even though trees were standing in the midst of dying trees, killed by this scale."

SUMMARY OF LIFE HISTORY.

The San Jose scale is one of a group of insects known as the armored scales, from the fact that they are protected by a shell or scale-like covering. The insect spends most of its life period under the scale. The only time it is capable of moving about is immediately after birth, and it crawls then only for a few hours. The adult male is also active a short time, as will be explained later.

The partially matured insects pass the winter under the scale. If, during this hibernating period, one of the scales is carefully turned with the point of a knife, a keen eye, without the aid of a magnifying glass, can detect a small, oval, wax-like mass about the size of the diameter of a pin. This is the real insect, although it has not the slightest resemblance to one. With the swelling of the buds, the young insects begin to take food and develop quite rapidly. The male scales begin to be quite prominent the latter part of April, the adult male insects appearing a few days later. The females reach maturity about the first week in June in this state, and begin to produce their young soon afterward.

The production of the young of the San Jose scale is quite different from that of most other insects. Instead of hatching from eggs, as is usually the case, the young are born alive, and the female is about six weeks producing her progeny. For this reason it has been very difficult to ascertain, with any degree of certainty, the exact number of broods, on account of the intermingling of generations, and, not until the appearance of Howard and Marlatt's Bulletin (No. 3), was the life history of the insect thoroughly and carefully elaborated. The observations were made by Theodore Pergande, an assistant in the Division of Entomology, U. S. Department of Agriculture, on potted plants in the department insectary.

The eggs are fairly well formed within the body of the female, and are enveloped in a very thin, delicate membrane, which is cast off at birth. The newly born insect remains motionless for a few minutes, until its delicate organs harden, so that it can move about. It then forces its way out from under the scale cover and crawls over the plant in search of a suitable place to attach itself.

When first born, the insects are extremely small, and can scarcely be detected by the naked eye. They are lemon yellow in color, with somewhat elongated, oval bodies, and only nine one-thousandths of an inch in length. The general appearance of the young creatures, looking at it from below, is shown in the illustration, figure 9. As indicated, it has six well, developed legs, two antennae or feelers, and a very long, thread-like beak or proboscis, through which it sucks the juice of the plant. After crawling a few hours, this lance-like beak is inserted into the plant tissues, and the young creature begins to exude from its back a mass of very fine, white, waxy filaments, and in about two days it is entirely covered with the external covering as shown at figure 10, *c. d.*

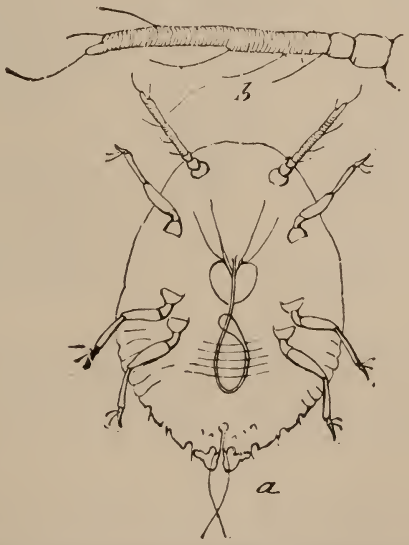

Figure 9. San Jose Scale; *a*, larva, greatly enlarged; *b*, antenna of same, still more enlarged. (After Howard, Circ. 3, New Series, Div. Ent., U. S. Dept. Agr.).

For the first twelve days after birth, one cannot distinguish the male from the female. At the expiration of this time, the molting begins, that is, the insects cast off their old skins, and the male can be distinguished by its size, being a little longer than the female, and the presence of eyes, the female having lost hers entirely.

About three weeks after birth, the male transforms to a true pupa, and from four to six days later, the adult emerges by backing out from under the scale. So far as we know, the males issue mainly at night. They are rather bold, peculiar looking insects, as shown at figure 11.

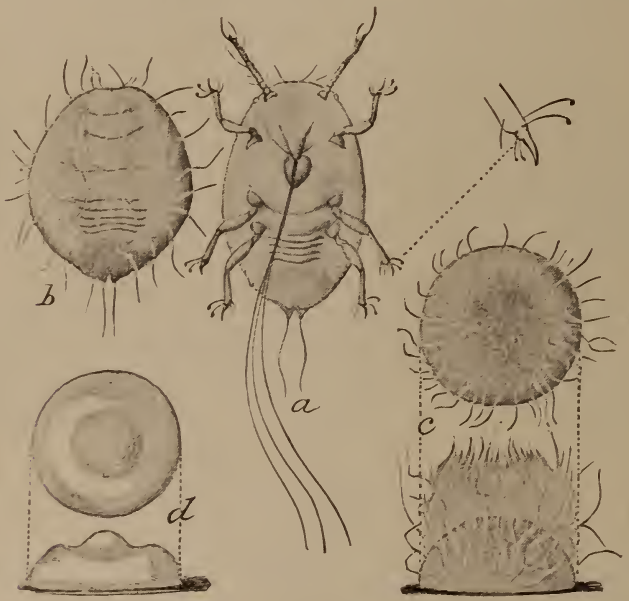

Figure 10.—Young larvæ and developing scale: *a*, ventral view of larvæ, showing sucking beak with setea separated, with enlarged tarsal claw at right; *b*, dorsal view of same, somewhat contracted, with the first waxy filaments appearing; *c*, dorsal and lateral views of same, still more contracted, illustrating further development of wax secretion; *d*, later stage of same, dorsal and lateral views, showing matting of wax secretions and first form of young scale—all greatly enlarged. (After Howard and Marlatt, Bull. 3, n. s. Div. Entom. Dept. Agr.)

They are rarely or never seen by the average observer, on account of their minuteness. They are only one-sixteenth of an inch in length. Their legs and antennae are quite large in proportion to the rest of the body. The body is of an orange color, while the wings are quite transparent, and of a silvery luster. It has no mouth, and therefore, takes no food, necessarily living a very short time, usually only a few hours. It is provided with a long, lance-like organ, known as the anal style, at the end of the body as shown in the illustration.

About thirty days from birth, the female reaches maturity, and the embryonic young can be seen within her body. From three to five days later, the young begin to make their appearance. The adult female is a very curious looking creature, being about one-twenty-fourth of an inch in length, pale yellow in color, and is wingless, legless and even eyeless, as seen at figure 12. She is provided with a very thread-like organ, resembling a whip lash, as shown in the illustration. This is the mouth part through which the food is taken, by inserting it into the plant tissues. By turning a fully matured scale in mid-summer with a knife or some sharp pointed instrument, the female can be seen. It resembles a mere bit of yellowish wax more than it does a living insect.

The length of a generation is determined by the female, and usually covers a period of from thirty-three to forty days. Mr. Theodore Pergande, under the direction of Dr. Howard, carried successive generations on potted plants throughout the summer in Washington, and found there were four full generations with a partial fifth. By these careful observations, the fecundity of the females, as well as the number of generations, was determined. It was shown that the males predominated the first and second generations, but in the third and fourth, the females considerably outnumbered the males. It was estimated that the number of descendants from a single female during one season was 3,216,080,400. Is it any wonder that a tree succumbs very quickly when these insects are left to propagate undisturbed? We would not expect that all the individuals would survive and perform their function in life; but under favorable conditions, it is safe to assume that a very large percentage reach maturity.

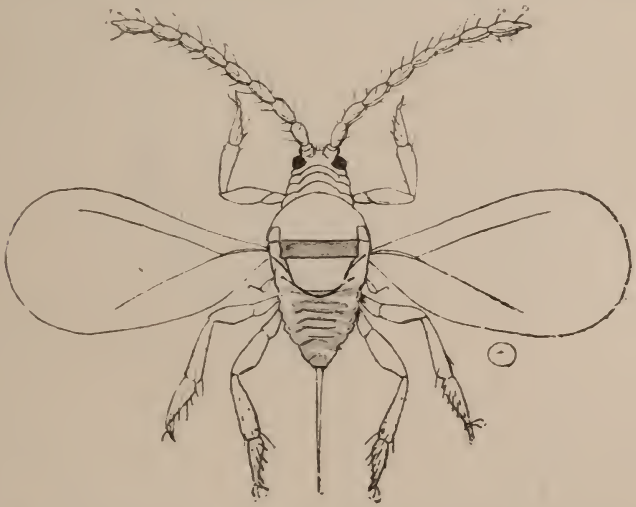

Figure 11.—San Jose scale, adult male, greatly enlarged. (After Howard, Circ. 3, Second Series, Div. Ent., U. Div. Agr.)

The young begin to appear in this latitude about the first week in June. The time, however, depending somewhat upon the weather conditions. In 1897 we observed the first young June 3; while in 1898 none appeared before June 11. The breading continues uninterrupted until checked by very cold weather. We have observed living young in Kent county under a scale with the parent insect, as late as December 19th.

It is not necessary in this place to give a detailed description of all the forms, as the foregoing remarks will suffice our purpose.

MEANS OF DISTRIBUTION.

The very nature of this insect is such, we must look to other agencies than itself for a general distribution. As already stated, the female is legless and wingless, and the young crawl only a very few hours, and even then they travel a comparatively short distance, before attaching themselves to the plant. The insect could only crawl from one tree to another where the limbs were interlocked, and such a condition rarely occurs in young orchards. In nurseries, however, there is no doubt but what the pest does spread by actually crawling from tree to tree.

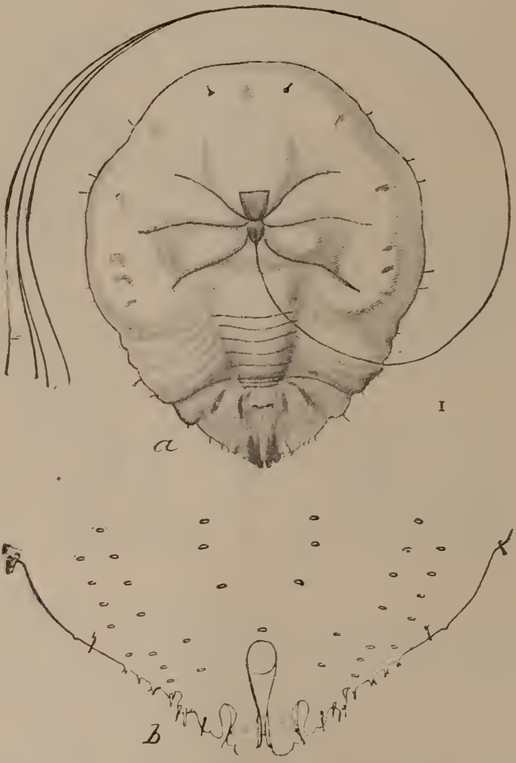

Figure 12.—San Jose Scale; *a* adult female, highly enlarged, ventral view showing sucking tubes; *b* anal plate, still enlarged. (After Howard & Marlatt, Bulletin 3, New Series, Div. Ent., U. S. Dept. Agr.)

In most instances, the pest is distributed on young trees, buds, grafts or scions, direct from the nursery. In this state, the infested trees in 57 orchards are directly traceable to the nurseries from which they came, as already stated. Once established, in an orchard, the spread is necessarily slow, but distribution is sure and gradual. The wind, in my opinion, is the greatest factor in carrying the young larvae from tree to tree. In one orchard near Sharpsburg, there is a noticeable instance of this kind, as stated in the detailed account of the outbreak in the various counties. Here the scale was first noticed on a few trees along the lower side of the orchard, and had spread up the side of the mountain, in the direction of the prevailing winds, infesting about 3,000 trees. Another case, of a similar nature, occurs in Frederick county, where the pest has gradually spread in an orchard of 2,500 trees. Still another instance, which strongly supports this view. was noted August 6th, 1897, in an orchard in Prince George county, where a milkweed growing midway between the trees was found badly infested with scale. Of course, there is a possibility that the scale may have been carried to this plant by either a bird or an insect, but the probabilities are slight.

To settle the question beyond all doubt, I made several experiments in two orchards which were badly infested, where the scale was breeding in great numbers, in August and September, 1897. In the first case, I selected a tree about ten feet high, and had a gentleman who was wearing a blue serge coat, stand about twelve feet from the trunk on the side toward which the wind was blowing. The wind was blowing a moderate breeze, and upon examination of the coat ten minutes later, I found many larvae crawling upon it. I had neglected to inspect the coat before we began the experiment, and therefore, the results were not definite, as we had been walking through the orchard, and the larvae may have been brushed from the trees. The experiment was repeated August 11th and September 9th, with definite results. In both instances, the larvae were blown from ten to fifteen feet, and lodged upon a piece of black cloth, which had been set up for that purpose. Close examination showed that many larvae were brushed off by the leaves and twigs as they scraped one against the other.

Birds also carry the scale sometimes long distances on their feet, legs and feathers. A notable case of this kind came under my observation March 15th, 1898, in an orchard in Howard county. I found a bird's nest in a tree about a third of a mile from a block of plum trees that was infested with scale. The twigs upon which the nest was resting were moderately infested with scale, and none were found on other parts of the tree or any of the surrounding trees. The natural inference was that the scale had been carried there by the bird when it returned after a visit to the infested trees. There are several instances of this kind upon record. and there is no doubt but what birds in an infested orchard are a great source of danger in spreading the scale.

Insects are also responsible for carrying the scale from place to place, especially the predaceous insects, or those that feed upon them. As noted in another place. a small. black ant was seen July 23rd, 1896. carrying one of these insects in its jaws. It is barely possible that ants carry these young larvae from plant to plant in certain cases, as already noted in this report.

The scale may also be carried accidentally by men and domestic animals. If. for instance. horses. cattle. sheep or hogs were allowed to graze in an orchard infested with scale. the chances are that they would brush against the infested trees. and transfer the pest to other trees.

Professor Rolfs cites a very interesting case that came under his observation in Florida. A gentleman who had some melons growing in an infested orchard, gave them to a friend, who took them away in a wagon. About a year later the scale appeared upon a tree under which the horses had been hitched while the melons had been unloaded. The inference naturally was that the young insects were carried to the tree on the wagon, harness, horses or melons, as there was no scale nearer than the point just mentioned, which was three miles away.

NATURAL ENEMIES.

Much has been said about the natural enemies of the San Jose scale, and I must say, a great deal of nonsense has been published by our agricultural and horticultural press on this subject, without due respect for the opinions of men who are devoting their entire time to the serious study of these reducing agents nature has provided. There is no question of a doubt that the introduction of the little Australian ladybug, *Vedalia cardinalis*, into California some years ago for the destruction of the cottony cushion scale, *Icerya purchasi*, was a signal triumph in economic entomology, and that it saved California her orange industry from inevitable ruin, but I am of the opinion it will be many a day before we see a similar repetition with any other insect. So far as the San Jose scale is concerned, we expect very little help in its destruction from its natural enemies.

TRUE PARASITES.

There are four species of true parasites known to feed upon the San Jose scale. Three of these have been bred in Maryland. One of them, *Anaphes gracilis*, How., having been reared from scale in no other state. It was bred by Dr. Howard from scales from Charles county. Two other species, *Aphelinus fuscipennis* How., and *Aphelinus mytilaspidis Le B.*, have been reared by myself from scales taken at the following places: Riverside, Annapolis Junction, Araby and Mitchellville. Thus

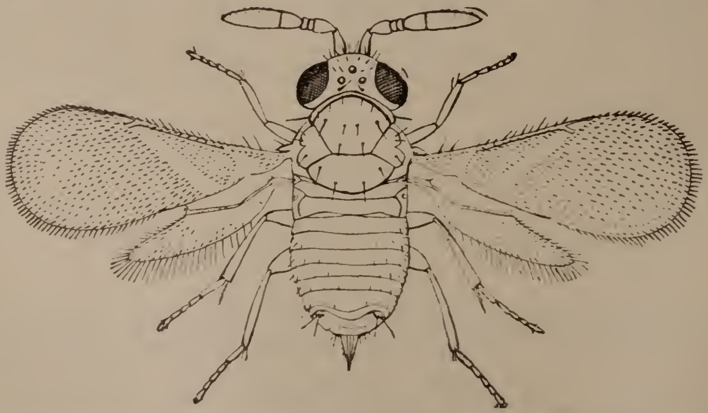

Figure 13. True Parasite, *Aphelinus diaspidis* Howard, of the San Jose Scale (After Howard in Bulletin 3, n. s. Div. Ent. Dept. Agr.)

it will be seen that three of the four parasites occur in Maryland. The other species, *Aspidiophagus citrinus* Craw., so far as I know, has been bred from the scale only in California and Florida.

These little friends are exceedingly small and are scarcely visible to the naked eye. *Aphelinus fuscipennis* measures only twenty-three thousandths of an inch in length, and has a wing expanse of fifty-one thousandths. A parasite greatly enlarged, belonging to this genus, is shown at figure 13, and will give a general idea of the appearance of these insects. We certainly cannot expect any immediate beneficial results from these parasites in this state. In all our efforts to secure them in our breeding cages, we have been obliged to enclose hundreds of thousands of scale to obtain one parasite. *Aphelinus fuscipennis* is no doubt, much more abundant in California than in eastern United States, but even there, partial extermination of the scale in certain orchards is seemingly due to a fungous disease, as pointed out by Howard and Marlatt.

PREDACEOUS INSECTS.

Of all insects which feed upon scales, the ladybugs are, perhaps, the most important. They are termed the predaceous enemies, and in this state, two species have been found feeding upon scale. The most efficient is a little, black creature about a sixteenth of an inch in length, known as *Pentilia misella*, and is shown at figure 14. It was first ob-

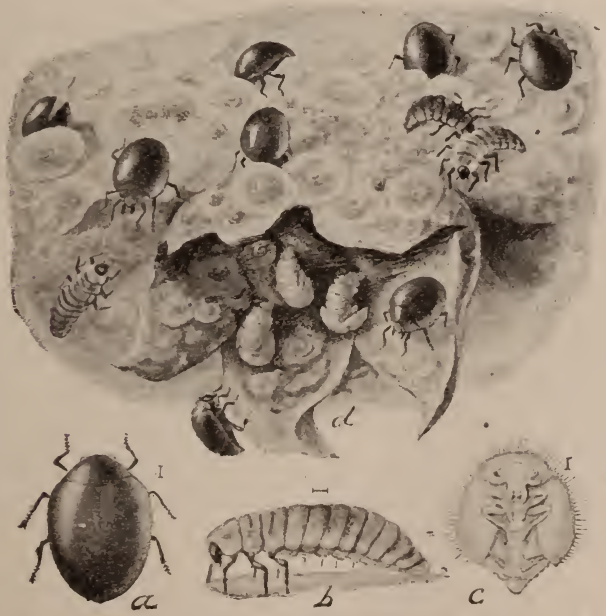

Figure 14. The minute, black Ladybug, *Pentilia misella; a*, beetle, *b* larva, *c*, pupa; *d*. blossom end of pear, showing scales with larvæ and pupæ of Pentilia, with the former feeding upon them, and the pupæ of Pentilia attached within the calyx—all greatly enlarged. (After Howard and Marlatt, Bull. 3, n. s. U. S. Dept. Agr. Div. Ent.)

served feeding on this scale by Mr. E. A. Schwartz, an assistant of Dr. Howard, at Charlottesville, Virginia. It is very common throughout this state in infested orchards. Both the larvae and adults feed upon the scales. The beetles prefer the mature females, but will feed ravenously upon all stages. I found the beetle very abundant in December, January and February at Annapolis Junction on plum trees that were badly infested with the scale. Thousands of them could be counted upon certain trees. I have also seen the same insect in almost every orchard in the state where the scale exists.

Another species known as the twice stabbed ladybug, *Chilocorus bivulnerus*, was observed feeding on the scale in several orchards. It was particularly abundant in the orchards at Araby and St. Margaret's. This beautiful jet black beetle and its young are shown in the illustration at figure 15.

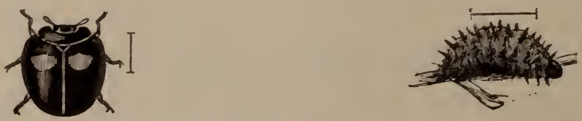

Figure 15. Twice Stabbed Ladybug, *Chilocorus bivulnerus* and its young; both enemies of the scale. (After Riley, 1st Mo. Rept.)

There are many people who believe that we should sit down, fold our hands, and let nature rid our orchards of the San Jose scale. It must be clearly understood that we have unbalanced nature to such an extent that we cannot expect to restore the equilibrium unless we assist nature ourselves.

Dr. Howard says (Bul. 3, p. 54): "Valuable as these natural enemies undoubtedly are, however, they will be efficient only at intervals, and there will always be considerable periods when, for some cause or another, they will be less numerous, and the scales will then have a chance to multiply. In fact, after the scale has become established, and the balance between it and its natural enemies has been reached, we may expect with more or less regularity periods of abundance and scarcity of the scale insects. The possible usefulness of parasites and predaceous insects, should, therefore, at least in the east, not be allowed for a moment to interfere with active operations with remedies, nor blind one to the importance of the San Jose scale, and the extraordinary precautions which would always be taken to prevent its wider dissemination."

In a bulletin (No. 12) by the same author, issued in March, 1898, he says: "In no case since the publication of bulletin No. 3, have any of the insect enemies of the scale been reported to have done any special good."

The State Horticultural Society of New Jersey, secured an appropriation of $1,000.00 in 1896 from the legislature for the purpose of importing into New Jersey certain ladybugs from California, which were said to be doing great good in reducing the scale. Dr. J. B. Smith, the State Entomologist, of New Jersey, was detailed to inspect the orchards in California, collect, and send colonies of the several species of ladybugs to New Jersey. Several colonies of various species were safely transported and liberated in infested New Jersey orchards. In regard to this introduction, Dr. Smith in his report for 1897, says: "Nothing has been seen in 1897 of the California Coccinellids introduced in 1896. Most of the places in New Jersey, in which they were introduced, were searched by myself on several occasions, but not a sign of the species has been noticed."

At the same time, Dr. Smith sent several colonies to Dr. Howard, in Washington, who reports that (Bull. 12); "No living specimens have been seen during 1897."

FUNGOUS DISEASES.

Like higher animals, insects are subject to the attacks of fungous diseases, and very often epidemics occur, which greatly reduce certain species.

The latter part of 1891, Mr. D. W. Coquillett, an assistant of the United States Department of Agricultural, then stationed in California, called attention (Bulletin No. 26, pp. 22-23) to a condition existing in an orchard near Pasedena, where he found the San Jose scale dead and dying from some unknown cause. As the orchard had not been treated with any insecticide, and no ladybugs and tree parasites were observed, he was of the opinion that this mortality was due to certain climatic influences, unless it could be shown to be due to some low form of fungus growth.

Prof. P. H. Rolfs, of the Florida Agricultural Experiment Station, who has given this subject considerable attention, has published the results of his observations and experiments in Bulletin No. 41, which appeared in August, 1897. He has found the parasite fungus, *Sphaerostilbe coccophila* occurring both on the San Jose scale and upon a common native species *Aspidiotus obscurus*. He has succeeded in cultivating the fungus on various materials in the laboratory, and has artificially inoculated trees infested with San Jose scale in orchards. There is some hope that this fungus can be used to good advantage from the economic standpoint in certain localities, but it is extremely doubtful, whether it can be successfully used in the northern states, as diseases of this kind are greatly influenced by climatic conditions. Entomologists of the north and west have already begun to test the disease, but so far, the results have not been very satisfactory. In January, 1898, I wrote Prof. Rolfs, requesting specimen twigs infested with the disease, to be used here for experimental purposes. A box containing specimen twigs infested with *Aspidiotus obscurus* and *A. perniciosus* was received January 13th. Twigs were tied in the branches of peach trees badly infested with San Jose scale in the vicinity of Frederick, but up to the present time, the disease has not spread from the original twigs.

February 25th, 1898, I received a lot of peach twigs infested with San Jose scale from Dorchester county, and upon examination, found that fully 95 per cent. of the insects were dead, from some unknown cause. The twigs had just been cut from the trees, and death could not have been due to the drying out of the soap. There were no external indications of the work of parasites or predaceous insects, and no fungus could be detected. I am of the opinion that death was due to some peculiar, local climatic condition, or to a bacterial disease.

HYDROCYANIC ACID GAS.

EARLY HISTORY.

Hydrocyanic acid gas has been used as an insecticide a comparatively short time. Its destructive properties to insect life were discovered by W. D. Coquillett, an assistant of the Division of Entomology, United States Department of Agriculture in 1886, while experimenting upon the cottony cushion scale, *Icerya purchasi* in orange orchards near Los Angeles, California.

In addition to the detailed account of the gas treatment given by Mr. Coquillett, in the report of the Department of Agriculture for 1887, and in Insect Life, Vol. 3, pages 457 to 460, by way of explanation, he wrote me March 21st, 1898, as follows:

"During the summer of 1886, I was employed by the United States Department of Agriculture to carry on a series of experiments at Los Angeles, California, against *Icerya purchasi*, but owing to an insufficient appropriation, I was laid off on the first of August of that year. As no perfect remedy had at that date been discovered, I determined to experiment with gases in a private capacity, and at my own expense. Accordingly, during the first week of the following month I began experimenting with hydrocyanic acid gas, which I thought would be the best for the purpose, owing to its very poisonous qualities, the rapidity of its generation and the readiness with which it diffuses itself in the air. Nobody suggested to me to try the gas. It was not until the following July that the Department of Agriculture again placed me on its rolls."

This series of experiments demonstrated the following facts, as recorded in Insect Life:

(1). That when the aqueous solution of cyanide was used, the trees were more liable to be injured by an overdose of the gas than when the cyanide was used dry.

(2). That trees treated in the hottest part of the day were more liable to be injured by an overdose of the gas than if treated in the earlier portion of the day or at night.

(3). That the use of a black tent in the day-time somewhat prevented injury to the trees by the gas, but only a comparatively slight degree.

Mr. Coquillett continued his experiments in 1887, using a tent constructed out of bed ticking and oiled with linseed oil. At this time he found, that by passing the gas through sulphuric acid. it was less liable to injure the trees. In 1888, other experiments were conducted for the purpose of testing the different brands of potassium cyanide; but it was not until 1889 that the process was finally perfected. Mr. Coquillett found by using the cyanide dry. along with two parts of water to one of sulphuric acid. and doing away with the device for circulating the gas in the tent. he got better results, and at the same time not so expensive. After Mr. Coquillett had perfected the equipment and found that the most satisfactory results were obtained at night. he gave his formula to some friends. who tried the method. and then applied for a patent on the gas treatment. which was finally granted in January. 1891. even

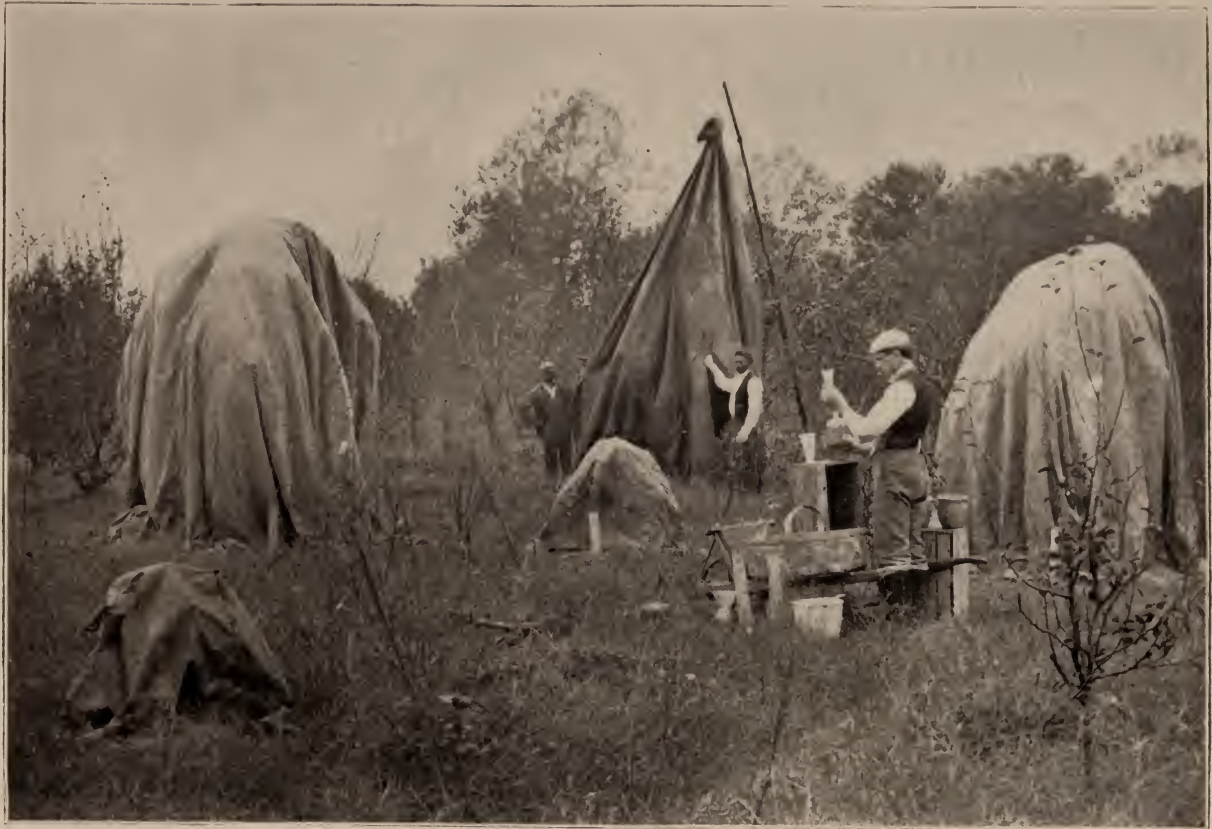

Figure 16.—Experimenting with Hydrocyanic Acid Gas in a block of 2500 Bartlett Pear Trees infested with San Jose Scale. Photo. taken October 16, 1897, by W. G. Johnson.

after the strongest protest on the part of Mr. Coquillett and Dr. Riley. The gas has been successfully applied in the orange orchards of this county for the destruction of scale insects since that time.

USE IN GREENHOUSES.

Professor Albert F. Woods, now Acting Chief of the Division of Vegetable Pathology, U. S. Department of Agriculture, conducted the first successful experiments with hydrocyanic acid gas in greenhouses in 1894. At that time he fumigated a large greenhouse filled with ferns, infested with scale insects, killing all the creatures without the slightest injury to the youngest growing fronds. His next experiment was in a house containing about 20,000 coleus plants, many varieties, badly infested with the white-tail mealy bug, *Orthesia insignis*. All the insects were killed without injury to the plants, much to the satisfaction of the owner, as he had exhausted every resource for their destruction, and was about to abandon the house.

Professor Woods and Mr. P. H. Dorsett, an assistant of the division, have since conducted many experiments, testing the effect of the gas upon various varieties of plants, and in the summer of 1897, made the most extensive application of gas ever made under cover. The houses fumigated contained 70,000 cubic feet of space, and about 10,000 violet plants badly infested with a black Aphis or plant louse were fumigated. This experiment was satisfactory in every respect, and the plants were completely rid of the pest.

The advantages of this gas in greenhouse work are summarized by Mr. Dorsett, in the Florists' Exchange for October 9th, 1897, as follows:

1. The effectiveness with which it acts.
2. Its rapid fusibility.
3. Ease of application.
4. It does not weaken the tissues of the plants when properly applied, but the method of using it has to be determined in each case.
5. It leaves no objectionable odor in the house; flowers such as violets, being as sweet immediately after its use as before.
6. A decrease in the number of applications necessary during the season.
7. Its use in ridding imported or exported stock of insect pests.

For clearing greenhouses of insect pests, slugs, etc., there is no remedy so satisfactory as hydrocyanic acid gas. It is easy to apply and inexpensive.

OPERATIONS IN MARYLAND.

From what I had seen of this method in California in orange orchards, I felt certain that it could be applied equally as effective to our deciduous fruit trees in the east, if properly handled. In the spring of 1897, I began a series of experiments upon young pear, apple, plum and nectarine, as recorded under experiments Nos. 1 to 7. The results of these experiments were so very satisfactory, I was prompted to continue my work on bearing trees in the fall of 1897.

Equipment:[*]—Through the generosity of Capt. Robt. S. Emory, of Chestertown, I was able to complete my equipment for this experiment. Personally, Capt. Emory has done more, perhaps, than other individual in the east or south, for the control and destruction of the San Jose scale. At his own expense, he furnished me eight tents, two others being purchased by the experiment station, and two were kindly loaned us by Dr. L. O. Howard. With this equipment of twelve tents, I was prepared to begin the largest series of experiments ever undertaken in orchards east of California.

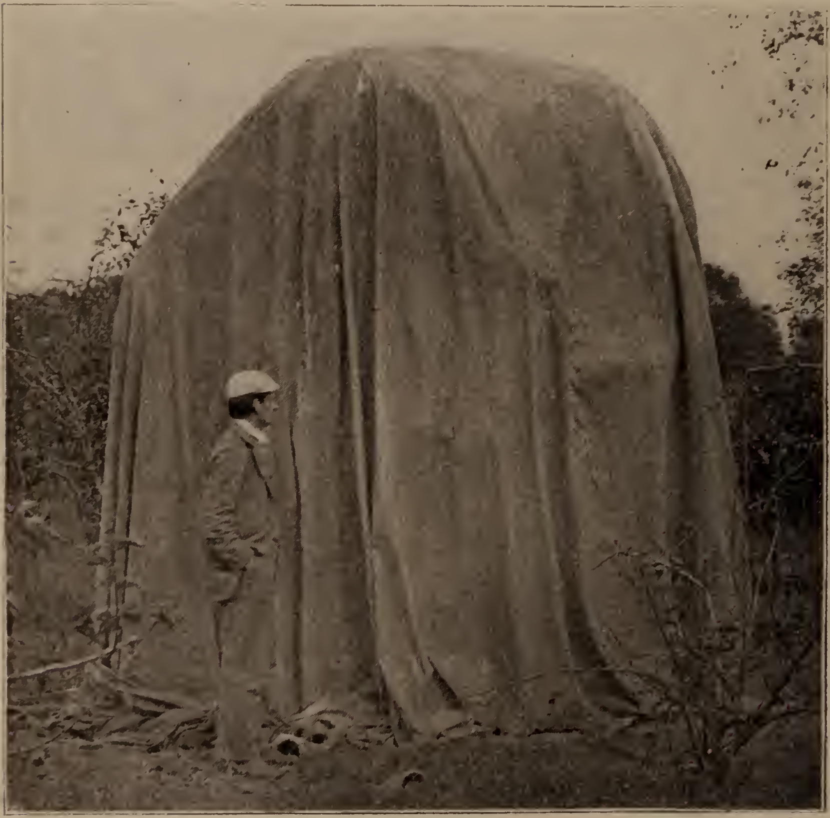

Figure 17.—A thirty-foot Sheet Tent covering a sixteen-foot tree. Photo. taken November 6, 1897, by W. G. Johnson.

Tents:—Our tents were of two forms, one was an octagonal sheet, modeled after those used by the U. S. Department of Agriculture, called a "sheet tent," and the other was what we term a "box tent," made according to a design by Capt. Emory. A thirty-foot sheet tent, covering a sixteen-foot pear tree is shown in the illustration at figure 17, and a fifteen-foot box tent, covering a twelve-foot tree, is illustrated at figure

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[*] The photographs of our equipment used in the Report of the Entomologist of the New Jersey Experiment Station for 1897, Figs. 12, 13 and 14 were reproduced and inserted without permission from this office.

18. Our sheet tents are of various sizes; one was forty-five feet in diameter, used only for very large trees, one thirty feet, and five twenty-five feet. The box tents also vary in size; two being fifteen feet square at the bottom, ten feet square at the top and fifteen feet high; two others have a seven-foot base, four-foot top and were ten feet high; still another which we call the "baby tent," has a four-foot base, two-foot top and is five feet high.

All the tents were made of eight ounce cotton duck, such as is used for making light sails. With a little care, any awning or tent maker can cut the sheets, so there is practically no waste in the material. They are cut and made into quadrants and then put together. The center in the large tents, for about two feet in diameter, is double, as there is considerable strain upon the material. A half-inch or five-eighths rope is hemmed in around the edges of both sheet and box tents.

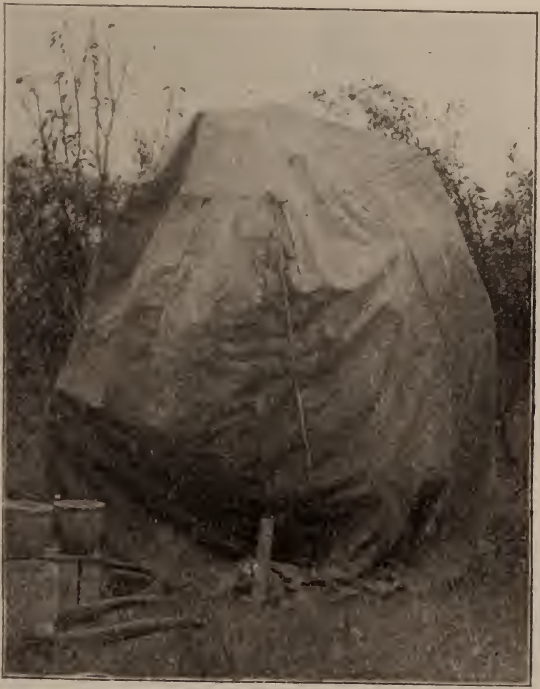

Figure 18.—A Box Tent in position covering a twelve-foot tree. Photo. taken November, 6, 1897, by W. G. Johnson.

I have found that the tents are much more easily handled by not putting gas pipe or anything stiff or heavy around the bottom, as is customary in some places.

The cost of the tent, of course, varies according to the size, and the cost of oiling must be added. All of our tents are thoroughly oiled by painting them with boiled linseed oil. The following quotations, which includes oiling, were secured in Baltimore, September, 1897:

Box tent	4x5x2	$4.00
Box tent	7x10x4	7.00
Box tent	10x15x15	12.50
Sheet tent	25 feet diameter	18.00
Sheet tent	30 feet diameter	25.00
Sheet tent	45 feet diameter	42.50

On the whole, the sheet tents are more easily handled than the box tents. The 7x10x4 box tent is very convenient for trees varying in size from four to eight feet, and I prefer it to the sheet for trees of the same size. The "baby tent" is of no practical account, as trees under four feet should not be covered with a tent at all, a barrel or box being much better for that purpose, as I will explain later on. The large box tent

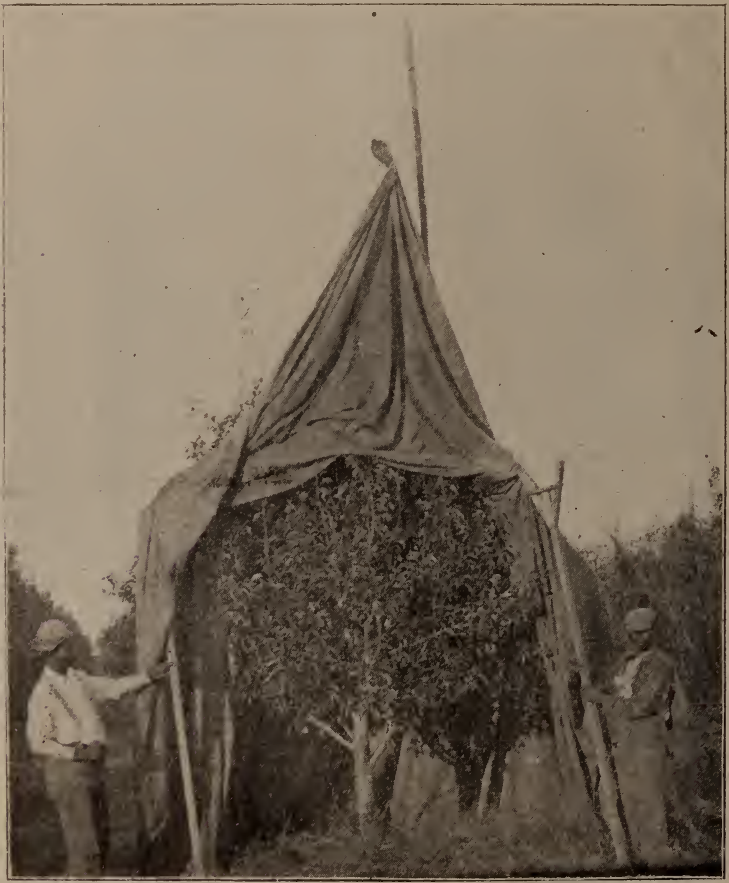

Figure 19.—Method of removing a tent. Photo. November 6, 1897, by W. G. Johnson.

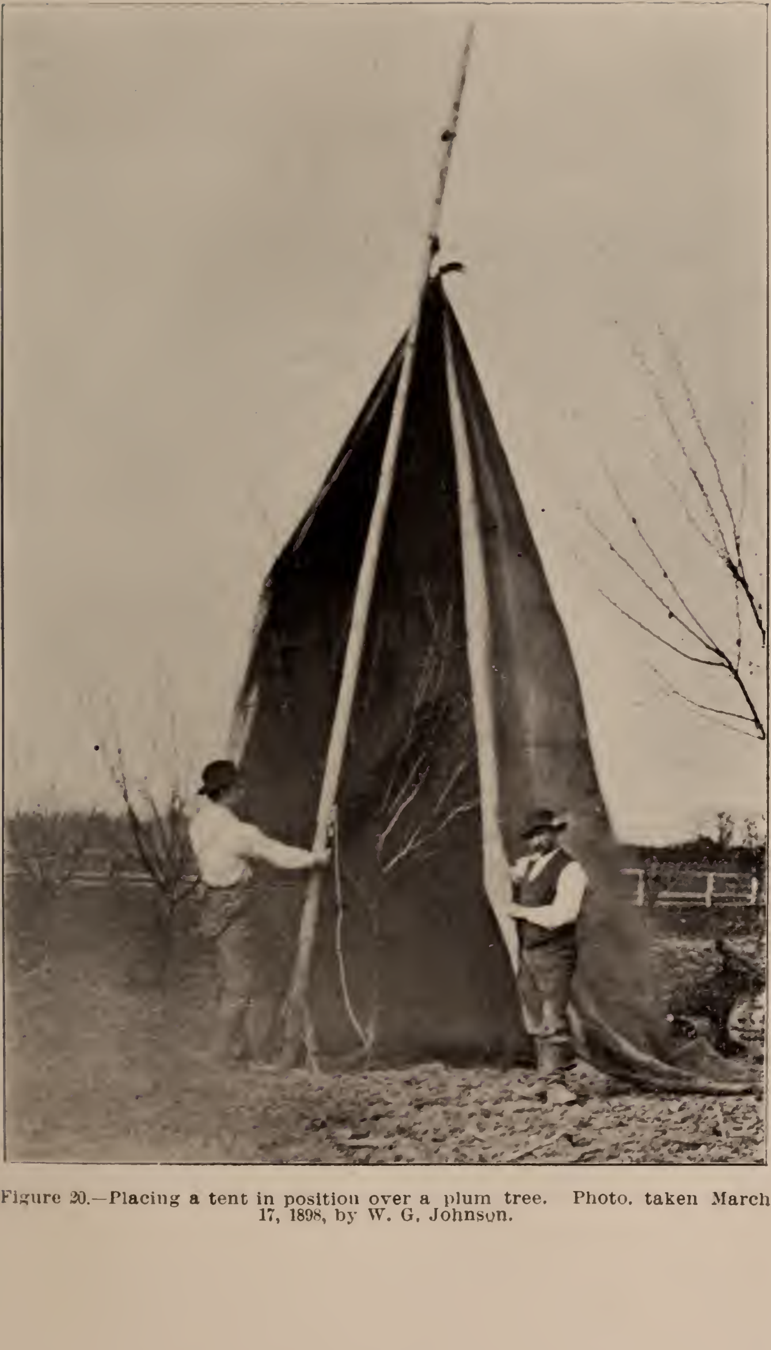

Figure 20.—Placing a tent in position over a plum tree. Photo. taken March 17, 1898, by W. G. Johnson.

is too cumbersome, and requires greater care and more time to tent and untent a tree with it than with the twenty-five foot sheet.

Lifter:—We used a single pole in our work for tenting and untenting a tree. The pole is known as the "lifter," and consists of an eighteen-foot yellow pine sapling, thoroughly seasoned, such as is used on small sail boats, about four inches in diameter at the base, tapering to about three inches at the top. It is strong, light and very durable. A piece of 3x4 inch scantling is nailed at the base and braced as shown in the illustration at figure 20. A small, block pulley, large enough to carry a five-eighths inch rope, is screwed near the top of the lifter. In my work, I use from forty to fifty feet of half or five-eighths inch rope in the pulley which is called the "pulley rope." About the height of one's shoulder is screwed a "Y," around which the rope is fastened when the tent is hoisted. Another piece of rope from twenty-five to thirty feet in length, is tied near the top of lifter above the pulley, and is called the "stay rope." It is by means of this rope that the lifter is kept in place, by tying the end to an adjacent tree as illustrated.

We use a small hand pole for assisting in untenting a tree, so as to keep the weight of the tent from the twigs. This is known as the "helper" and is shown at figure 19.

Chemicals:—The chemicals used are (1) Cyanide of Potassium, (2) Sulphuric acid and (3) water. The cyanide must be practically chemically pure, guaranteed 98-99 per cent. It can be bought for about 30 cents per pound in bulk. The prices quoted me by the manufacturers* vary from thirty to thirty-two cents per pound in bulk of 100 pound lots and from 32½ to 35 cents in smaller quantities, and are subject to advance without notice.

I find that cyanide broken into lumps about the size of shell bark hickory nuts give better results and is more satisfactory to handle than large lumps. It can be procured in small lumps by notifying the manufacturer.

The best grade of commercial sulphuric acid, (sp. gr. 1.83) should be used. A grade used ordinarily in the manufacture of fertilizer (chamber acid) will not do. I secured an excellent grade from the manufacturers** at 1½ cents per pound by the carboy. This substance is also subject to advance in price.

Water from any ordinary well or cistern will suffice, the only requisite being that it should be clean.

Other materials:—There are several other materials needed for the work. (1) I find that pickle jars, holding from two to four quarts are the best adapted for the chemicals, for the generation of the gas. There should be at least as many jars as there are tents in operation; (2) A cheap, flat basket about eighteen inches or two feet long and a foot wide with partitions made of thin boards dividing it into about six or eight compartments, is necessary for carrying the cyanide; (3) A liberal supply of small paper bags holding about a pint or a little less. The cyanide is weighed out into the various amounts needed, placed in the bags and carried in the basket. *Caution:* Care should be taken not to weigh too much cyanide at a time as the bags become saturated with moisture when the cyanide is long exposed to the air, and they are hard to handle. It is policy to weigh the material at night or early in the morning, or during the noon hour, and when not in use in the orchard, the bags should be kept in an airtight can. (4) A graduated glass beaker, holding at least, eight ounces, for measuring the acid and water; (5) A bottle with glass stopper, holding about two quarts for acid; (6) A pail for water; (7) A tin cup for dipping water; (8) A wheelbarrow and a small wooden box upon which the utensils can be kept, and (9) as many small pieces of boards, with smooth surface, about two feet long by two or three inches wide, with one end sharpened, as there are tents. These are used for recording time during fumigation and are stuck into the ground near the tent. The entire outfit at work is shown in the illustration at figure 16.

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*Alonzo L. Thomsen, M'f'g. Chemist, Baltimore, Md., and Roessler & Hasslacher Chemical Co., 100 William Street, New York.

**John J. Thomsen's Sons, Baltimore, Md.

Tenting a Tree:—The lifter is set at an angle of about sixty degrees, and the stay rope fastened to an adjoining tree, thus holding it in place. One end of the pulley rope is then passed around the tree and tied to the tent lying on the ground on the opposite side. The operator at the lifter then draws the tent to the pulley and fastens the rope. He then steps back a few feet and taking the stay rope pulls the lifter towards himself until the center of the tent is about over the top of the tree. In the meantime, the other assistant brings the sides of the tent around toward the lifter and the operator takes one side while the assistant holds the other, as shown in the illustration at figure 20. When the lifter is at the proper angle to bring the center of the tent over the top of the tree, one side of the tent is then passed to the assistant between the lifter and the tree; while the operator loosens his pulley rope and lets the tent fall in position. The assistant unties the stay and pulley ropes and carries the lifter to the next tree; while the operator "banks" the tent; that is, he folds it in around the base of the tree and tramps it down or throws a few shovels full of earth around it as may be required. If the wind is blowing, and the tent is a little slack, a few pieces of stone or chunks of wood may be required. This done, every thing is in readiness for the chemicals.

When the trees are uniform in size, as many rows are taken as there are tents. The sheets tents are then transferred from tree to tree by simply reversing them over and over again. The method varies from the foregoing only in that the pulley rope is carried around to the side opposite the lifter, and fastened to the bottom of the tent covering the tree. The lifter is also set at a more acute angle. The box tents cannot be reversed in this manner, and must in each instance, be taken from the tree, lowered and again hoisted. The method of untenting a tree is shown at figure 19.

Caution:—Care should be taken in handling the tent so as not to break the branches and fruit spurs. The weight of the tent should be lifted by means of the helpers, as shown in the illustration. On very large trees two lifters are necessary, and in this way the weight of the tent is kept from the tree until it is ready to be lowered.

Placing Chemicals:—As soon as the tent drops over the tree, the expert estimates the capacity and measures the acid and water. He places the acid in the jar, and carries the water in the beaker. He then raises up one side of the tent, puts the jar in place, pours in the water, tears the top from the bag and drops cyanide, bag and all into the jar, closing down the tent as soon as possible. He then marks upon the time board when the tent is to be removed.

Caution:—The acid should never be carried in the beaker, as there is danger of getting it upon the tent. It is also well to dip one's hands into water occasionally to wash off any acid which would otherwise make finger marks on the tent. The jar should always be placed upon a level surface, as near the trunk of the tree as possible, and see that the tent is not folded in near it, as the acid sometimes spatters as the gas is generating. After a tent is removed, care should be taken where the residue in the jar is thrown, otherwise a tent will be dragged through it and ruined. My plan is to empty the jar where it stands.

Estimating Amounts:—An expert soon becomes so proficient he can estimate the height and diameter of a tented tree at a glance, and by referring to his table of amounts, measures the acid and water without delay.

I have found some little difficulty in estimating the cubic contents of a tented tree. The figure is neither a cylinder nor a sphere, but lies between the two. In the preparation of the following table, I have based my calculations on the height and diameter of the tented tree. First, I calculated the cubic contents of a cylinder whose height and diameter were the height and diameter of the tree, then calculated the contents of a sphere whose diameter was the height of the tree. Then by taking half the difference and adding it to the contents of the cylinder, I found my estimation was approximately correct.

I have found in my experimental work that 0.20 of a gram of Potassium Cyanide per cubic foot of space enclosed, gave me the most satisfactory results upon scale infested, deciduous trees. The following table of amounts is calculated according to this standard. The amount of acid used is always one-half more than the cyanide, and the water is a half more than the acid. For instance, if I use 1 ounce (by weight) of cyanide, there will be 1½ ounces (liquid measure) of acid and 2¼ ounces of water.

TABLE OF AMOUNTS.

HEIGHT OF TREE.	DIAMETER.	CYANIDE.	ACID.	WATER.
Feet.		Grams.	Ounces.	Ounces.
4	3	6.17	0.32	0.48
5	4	12.82	0.67	1.00
6	4	18.85	1.00	1.50
7	4	26.75	1.41	2.11
		Ounces.		
7	5	1.11	1.66	2.49
8	4	1.30	1.95	2.92
8	5	1.50	2.25	3.39
9	5	1.96	2.94	4.41
9	6	2.24	3.36	5.00
10	7	3.20	4.80	7.20
10	8	3.62	5.43	8.14
11	7	3.95	5.92	8.88
11	8	4.40	6.60	9.90
12	9	5.88	8.82	13.23
12	10	6.51	9.76	14.64
13	9	6.93	10.39	15.58
13	10	7.65	11.47	17.20
14	11	9.76	14.64	21.96
14	12	10.65	15.97	23.45
15	11	13.28	19.42	29.88
15	12	14.24	21.36	32.04
16	14	16.34	24.51	36.76
16	15	17.53	26.27	39.43
17	14	18.39	27.57	41.35
17	15	19.36	29.40	44.23
18	15	22.06	33.09	49.63
19	16	26.10	39.15	58.72
20	16	29.00	43.50	65.25

EXPERIMENTAL OPERATIONS.

In the fall of 1896, I discovered a lot of badly infested trees of various varieties in young orchards and nurseries, and decided to make a thorough test of the hydrocyanic acid gas treatment. Accordingly, the trees were selected for the work, and the experiments begun in March, 1897. The outcome of these tests show:

(1). That young trees, either from the nursery or orchard, can be fumigated without injury to the tree.

(2). That the San Jose scale can be completely destroyed, the only requisites necessary being a good, tight room, box or tent, constructed for the purpose, and the chemicals.

Young Trees:—The following experiments were made upon young trees direct from the nursery or from young orchards of one year's standing. All the trees in these experiments were treated in a fumigatorium, especially constructed for that purpose. The room was 4x7x7½ feet.

No. 1—Four Angouleme pear trees, literally covered with San Jose scale, discovered in one year old orchard November 18th, 1896, were taken up and fumigated March 22d, 1898, for thirty minutes with two ounces cyanide, three ounces acid, and four and one-half ounces water. Planted near my house April 3rd. Made excellent growth during the summer, and not a living scale has yet been discovered upon them. Examination made once a week. Old scales most all washed off. Pits and scars still present. April 1st, 1898, trees making beautiful growth and no live scale.

No. 2—Three Lawrence pear from a nursery, treated same day and planted under same conditions as No. 1. Trees were very badly infested with scale. Examined every week during the summer and fall of 1897, and not a living scale has yet been detected. Trees made a beautiful growth.

No. 3—Six Garber pear trees from young orchard, originally from a southern nursery, treated like Nos. 1 and 2, and at the same time. Trees planted April 4th, 1897, and watched closely throughout the summer and fall. Not a living scale found. Trees also critically examined in January, 1898, when the foliage was off, but no live scale could be found, and most of the old scales had become detached, leaving the bark pitted and marked.

No. 4—Two Clapp's Favorite pear trees from the nursery row treated at the same time and like the three preceding. Trees planted April 4th, 1898. These trees were also moderately infested with scale. Results same as the foregoing.

No. 5—Two Abundance plum trees from a young orchard of one year's standing, very badly infested, treated as the above. Planted April 5th, 1897. Both made excellent growth and no living scale has yet been discovered on them.

No. 6—Four Ben Davis apple trees, two from a one year old orchard and two from a nursery. Treated as above April 5th, 1897. Planted April 7th. Those from the orchard were very badly infested, the trunks and larger branches being literally encrusted with scale. No living scale found any time during the summer or winter months. Trees made good growth.

No. 7—Consisted of miscellaneous lot of nursery stock as follows: 2 Wheatland peach; 4 Oldenburg and 3 Winesap apple; 2 Early Purple cherry; 2 Burbank, 1 Ogon and 4 Satsuma plum; 2 Standwick nectarine and 1 Prunus pissardi. All these varieties were badly infested with scale, and were fumigated together for thirty-five minutes, September 24th, 1897. The amount of gas generated was the same as in the preceding. All these trees were set out and watched carefully, and not a single living scale has yet been discovered.

St. Margarets:—A series of experiments were begun at this place March 4th, 1898, upon peach trees one year from the nursery, which were badly infested with the San Jose scale. The trees were grown by the owner, A. A. Stinchcomb, as already cited on page 21. The object of the experiment was to ascertain whether or not an ordinary room in a frame building with lath and plaster could be used successfully for fumigating purposes. The building was a small, frame structure, 16 feet square, divided into two rooms, each 7¾ feet wide, 15¼ feet long and 7¼ feet high. The room selected contained two windows, and one door opening into the other room. The floor was tight, but to prevent any escape of gas, it was covered to a depth of about two inches around the edges with loose earth, which was packed close to the mop-board. The cracks in the windows were also stopped up with paper. The trees were divided into two lots of about 1,000 each, the first of which was fumigated March 4th, from 11.50 a. m. to 12.30 p. m.; and the second, March 5th, from 3.52 p. m. to 4.32 p. m. Each lot remained in the house forty minutes as indicated. The amount of potassium cyanide was a little larger than ordinarily used. The chemicals were as follows: cyanide, 8 ounces; acid, 12 ounces and water, 18 ounces.

The trees were then removed, and planted again in the orchard. They have made a good start this spring, and so far as can be ascertained at present, May15th, there are no living insects. 14 trees from this lot were brought to the experiment station, and set out for observation. They were all very badly infested, but not a living insect has been found to June 1st. The trees are all alive and growing fairly well, considering the weather. Six trees from this lot not fumigated were planted as a check upon the others. May 15th the scales were alive, but no young had appeared. Young were found crawling on all the trees June 13th. They were removed and burned June 14th, for fear that the young would get on the other trees. At this time no young or living insects could be found on the fumigated trees.

Bearing Trees:—The results of the foregoing experiments were so gratifying, that I decided to continue my work on a more extended plan on bearing trees, and with the equipment already described, I began my observations.

I started out to determine the following points:

(1)—The physiological effect of the gas upon the tree;

(2)—The effect of the gas upon the San Jose scale; and

(3)—The practical utility of using this method in the east and south during all kinds of weather conditions in large bearing orchards.

To determine the first two points, many preliminary experiments were necessary, and when these were finished, the third point was taken up and continued from October 16th to November 27th, 1897.

The orchard chosen for these operations belongs to Capt. R. S. Emory, and contains about 2,500 nine year old Dwarf Bartlett pear trees, which had become infested with the scale from an adjoining young Lawson pear orchard. All the trees were in excellent condition and full of foliage. The scales were breeding and active, and taking it all in all, the conditions could not have been more favorable for my experiments. The preliminary tests were begun September 27th, 1897, continued at all hours of the day, and at night, and were finished October 1st.

Chestertown:—A list of these experiments is given herewith simply as a matter of record. The trees selected for the purpose varied in size from five to ten feet, were full of foliage and in excellent condition, as noted above.

No. 1—Tented at 8.48 a. m., removed at 9.18 a. m.; height of tree five feet; temperature 66 degrees; time thirty minutes; cyanide ½ oz.; acid 1½ ozs.; water 3¼ ozs. Foliage not hurt.

No. 2—Time 9.03 to 9.33 a. m.; height five feet; temperature 66 degrees; time thirty minutes; chemicals same as No. 1, foliage slightly singed.

No. 3—Time 9.18 to 9.48 a. m. Repetition of No. 2, except that foliage was slightly more singed.

No. 4.—Time 9.32 to 10.02 a. m., same as above, except temperature, which was 67 degrees. Foliage singed.

No. 5—Time 9.35 to 10.18 a. m., same as above.

No. 6—Time 9.55 to 10.25 a. m., same as above. Temperature 67.5 degrees, foliage quite badly singed.

No. 7—Time 10.32 to 11.02 a. m., same as above.

No. 8—Time 11.00 to 11.30 a. m., same as above Temperature 69.6 degrees. Foliage very badly singed.

No. 9—Time 11.10 to 11.40 a. m., same as above.

No. 10—Time 11.30 to 12.00 a. m., same as above. Temperature 70 degrees

No. 11—Time 11.37 a. m. to 12.13 p. m., same as above. This was immediately followed by a second dose of the same amount from 12.13 to 12.43 p. m., or in other words, the tree was given the same treatment as the others double time. Temperature 70 degrees. Foliage very badly singed. This treatment did not injure the leaf or fruit buds in the least. The trees at the present time (May) is full of foliage and set full of fruit.

No. 12—Time 11.40 a. m. to 12.20 p. m. Height of tree same as above. Temperature 70.5 degrees. Chemicals used same as in all the preceding experiments, except No. 11. Foliage badly singed.

No. 13—Time 12.06 to 12.36 p. m., same as above.

No. 14—Time 1.05 to 1.35 p. m. Height of tree seven feet. Temperature 70.5. Cyanide 1 oz.; acid 1½ ozs.; water 2¼. Foliage badly singed.

No. 15—Time 1.16 to 1.46 p. m. Height five feet. Temperature 70.5 degrees. Foliage badly singed.

No. 16—Time 1.16 to 1.46 p. m. Height five feet. Temperature 70.5. Foliage badly singed.

No. 17—Time 1.47 to 2.17 p. m. Height nine feet. Temperature 70.5 degrees. Cyanide 2½, acid 3¾ and water 5¼ ozs. Foliage badly singed.

No. 18—Time 1.43 to 2.21 p. m. Height six feet. Temperature 70.5. Cyanide ¾ oz.; acid 1¼ ozs.; and water 2 ozs. Foliage badly singed.

No. 19—Time 2.15 to 2.45 p. m. Height five feet. Temperature 70. 5. Other conditions same as for other five foot trees. Foliage badly singed.

No. 20—Time 2.20 to 2.50 p. m. Height six feet. Temperature 70.5 degrees. Cyanide ¾ oz.; acid ¼ oz.; water 2 oz. Foliage badly singed.

No. 21—Time 3.00 to 3.30 p. m. Height six feet. Temperature 70 degrees. Conditions same as No. 20. Effect same.

No. 22—Time 3.12 to 3.42 p. m. Height five feet. Temperature 68 degrees. Conditions same as above for five foot trees.

No. 23—Time 3.12 to 3.42 p. m. Height five feet. Temperature 68 degrees. Other conditions same as No. 22, except that foliage not so badly singed.

No. 24—Time 3.36 to 4.06 p. m. Height six feet. Temperature 66.5 degrees. Cyanide ¾; acid 1¼ ozs.; water 2 ozs. Foliage not much injured.

No. 25—Time 3.42 to 4.18 p. m. Height five feet. Temperature 66½ degrees. Chemicals same as above. Foliage slightly affected.

No. 26—Time 3.40 to 4.18 p. m. Height five feet. Temperature and conditions same as above.

No. 27—Time 4.15 to 4.45 p. m. Height six feet. Temperature 66 degrees. Foliage very little hurt.

No. 28—Time 4.30 to 5.00 p. m. Height five feet. Results same as above.

No. 29—Time 4.30 to 5.00 p. m. Height five feet. Results same as above.

No. 30—Time 4.55 to 5.25 p. m. Height six feet. Temperature 65.5 degrees. Foliage hurt very little.

No. 31—Date September 28th. Time 8.23 to 9.03 a. m. Height six feet. Temperature varied from 59 to 68 degrees. Time 40 minutes. Foliage slightly injured.

No. 32—Time 8.40 to 9.10 a. m. Height five feet. Foliage slightly damaged.

No. 33—Time 9.15 to 9.55. 40 minutes. Height five feet. Temperature 68. Results same as above.

No. 34—Time 9.45 to 10.15 a. m. Height five feet. Results same as above.

No. 35—Time 9.45 to 10.15. Height five feet. Results same as above.

No. 36—Time 10.05 to 10.35 a. m. Height five feet. Results same as above.

No. 37—Time 10.25 to 10.55. Height five feet. Foliage considerably damaged.

No. 38—Time 10.25 to 10.55. Height five feet. Results same as above.

No. 39—Time 10.40 to 11.20 a. m. Height six feet. Temperature 68 degrees. Foliage quite brown.

No. 40—Time 11.00 to 11.30 a. m. Height five feet. Results same as above.

No. 41—Time 11.00 to 11.30 a. m. Height five feet. Results same as above.

No. 42—Time 11.15 to 11.45 a. m. Height six feet. Foliage very badly singed.

No. 43—Time 11.32 a. m. to 12.02 p. m. Height five feet. Leaves very brown. Temperature 70 degrees.

No. 44.—Time 11.32 a. m. to 12.02 p. m. Results same as above.

No. 45—This tree was covered with one of the old tents from the United States Department of Agriculture. Time 2.21 to 2.56 p. m. Height ten feet. Temperature 70 degrees. Cyanide 4 ozs.; acid 6 ozs.;

water 9 ozs. Although this tree was fumigated in the heat of the day, not a leaf on the tree was affected. We, therefore, suspected that the tents did not hold the gas properly and after several other preliminary tests, we found that our suspicion was well grounded, as the tent had been in use for some time, and the oil had been quite well worked out of it. Two days later, quite a large percentage of the insects upon the tree were found still living. This tree was again fumigated October 16th with one of the new tents, this time using the same amount of chemicals as formerly. The foliage after this treatment became very brown, and we were unable to find any living insects.

No. 46—Time 2.23 to 2.53 p. m. Height of tree eight feet. Temperature 70 degrees. Cyanide 2 ozs.; acid 3 ozs.; water 4½ ozs. This experiment was a duplicate of the one preceding (No. 45), and the results obtained were similar. The trees was again fumigated October 16th.

No. 47—September 29th. Time 1.48 to 2.18 p. m. Height eight feet. Temperature 70 degrees. Cyanide 1¾ ozs.; acid 2½ ozs.; water 3¾ ozs. Foliage badly singed.

No. 48—Time 2.28 to 2.58 p. m. Height eight feet. Temperature 70 degrees. Cyanide 2 ozs.; acid 3 ozs.; water 4½ ozs. Leaves very badly singed. Petioles black almost to the base.

The two experiments immediately preceding were made to test the effect of a very strong dose of gas during the heat of the day. The amount of cyanide was about double the quantity ordinarily used, and the tests were made to see the effect upon the foliage, the leaf and fruit buds this spring. Both trees put out their foliage at the ordinary time, and the amount of fruit is as much as on any of the adjoining trees. Although this may be considered a double treatment, not even the buds on the most tender growth were affected. The leaves, however, on both trees were very brown, in fact, almost black within five minutes after the tents were removed. We were of the opinion that if the gas treatment affected the development of the fruit and leaf buds upon any trees in this orchard, it would certainly show itself in these tests, but we cannot at the present time (May), see any difference between these trees and those treated with smaller amounts, except that there is very little fruit set.

No. 49—September 30th. Time 2.33 to 3.02 p. m. Height eight feet. Temperature 77 degrees. Cyanide 1 oz.; acid 1½ ozs.; water 2¼ ozs. Foliage quite brown.

No. 50—Time 3.15 to 3.45 p. m. Height eight feet. Temperature 77 degrees. Cyanide ¾ oz.; acid 1¼ ozs.; water 2 ozs. Foliage slightly singed.

The two preceding experiments were performed in order that they may be brought in comparison with Nos. 47 and 48. The effect of the gas upon Nos. 49 and 50 was not so distinctly marked, very few fruit buds being hurt, as upon the two preceding, when fully 95 per cent. of the fruit buds were destroyed.

The two experiments which follow were made with the view of comparing the effects of day treatment with trees fumigated at night. I was especially desirous to see the effect upon the foliage as well as the dormant leaf and fruit buds.

No. 51—September 30th. Time 7.09 to 7.39 p. m., very dark. Height eight feet. Temperature 60 degrees. Cyanide 1¾ ozs.; acid 2½ ozs.; water 2¾ ozs.

No. 52—Time 7.47 to 8.17 p. m. Height eight feet. Temperature 58 degrees. Cyanide 1 oz.; acid 1½ ozs.; water 2¼ ozs.

The foliage on these trees was not injured in the least, so far as indications presented themselves during the next five days. The trees retained their leaves in good condition, but noticed one peculiarity in that they became yellowish and dropped a day or two sooner than those on trees immediately surrounding, which had not been fumigated. There was no singing or brown effect whatever, and the foliage seemed to be normal in every respect. The results obtained from these experiments compared with Nos. 47 and 49, in which similar amounts of gas were generated during the heat of the day, are very striking. In the day experiments, the leaves were very badly singed, while those fumigated at night were not hurt at all. At the same time, so far as the fruit and leaf buds were concerned, the former were nearly all killed by the day, while none were injured by the night treatment.

No. 53—October 1st. Time 11.21 to 11.51 a. m. Height ten feet. Temperature 75 degrees. Cyanide 3½ ozs.; acid 5¾ ozs.; water 8½ ozs. The foliage in this instance was badly singed, but the fruit and leaf buds were not injured in the least.

These tests show conclusively (1) that the gas is most injurious to foliage during sun-shiny days, late in the fall, between 9 a. m. and 4 p. m. In every instance where trees were treated between these hours, the foliage was singed. In several instances, it was perfectly brown, looking much like the effects resulting from a heavy frost. One important point was noted, however, that the leaf petioles were blackened about two-thirds their length, the base being perfectly green, and, therefore, the leaves fell readily a few weeks later. Another point that should be noted in this place, is the fact that the function of the foliage had been performed, consequently, we used the gas much stronger than we would have done at any other season when the trees were in full foliage.

(2.) That the dormant leaf and fruit buds, on the trees treated with gas sufficient to turn the leaves brown in the fall, are not injured.

(3.) That leaves which have been singed by the gas fall readily and do not remain clinging to the tree.

(4.) That trees treated in the morning before 9 a. m., and in the afternoon after 4 p. m., have the foliage very little affected by the gas.

(5.) That trees treated at night with very strong doses of gas do not have the foliage or dormant leaf and fruit buds affected at all, even where double the amount of gas ordinarily used is generated.

(6.) That the San Jose scale is entirely destroyed by the gas when used on calm, dry, sunny or cloudy days.

(7.) That the cost of treatment, aside from the equipment, is less than the whale oil soap.

Having completed these preliminary tests, we were so gratified with the results, we decided to have a field meeting for the purpose of having those who were especially interested in this matter present with us in order that they might examine and see our equipment in operation. Accordingly, an invitation was sent out at the request of Capt. Emory, and the following gentlemen responded and were present at the meeting October 15th, 1897: Dr. A. F. Woods, Acting Chief of the Division of Vegetable Pathology, U. S. Department of Agriculture; Prof. G. Harold Powell, Entomologist and Horticulturalist, of the Delaware Experiment Station; Dr. J. B. Smith, State Entomologist, of New Jersey; Dr. A. T. Neale, Director of the Delaware Agricultural Experiment Station; Dr. J. J. Black, a prominent and successful grower of New Castle, Delaware; Wesley Webb, Secretary, of the Peninsular Horticultural Society, of Dover, Delaware; Senator Charles T. Wescott; Dr. C. P. Gilpin; Mr. C. C. Hopper, Editor Transcript; Edward W. Emory; Dr. W. Frank Hines; W. S. Walker; Wilbur Eliason; and C. S. Hill, of Chestertown and vicinity.

In the evening, Capt. Emory served his guests a sumptuous dinner, and several toasts were responded to, and all were unanimous in the opinion that the experiment was complete in every respect.

Weather Conditions:—This experiment was prosecuted during all kinds of weather. We had sunshiny, cloudy and foggy days; rain, sleet and snow: windy and calm weather. The following abstracts from our daily diary will give a fair idea of the conditions under which we worked:

October 16th—Clear and calm. Temperature 90 degrees at 2 p. m. Foliage much burned.

October 17th—Sunday, sunny. Temperature 74 degrees at 3 p. m.

October 18th—Clear and calm. Temperature 76 degrees at 2 p. m. Foliage burned.

October 19th—Cloudy. Temperature 68 degrees. Foliage not hurt.

October 20th—Rain and wind. Temperature 54 degrees; rain stopped about noon. Windy, tree quite wet. No trees treated until after 2 p. m. Conditions unfavorable; too windy. Foliage not hurt.

October 21st—Cloudy and damp. Trees wet. Temperature 58 degrees at 8 a. m. Began work at 7.30, and tented trees and had gas generating in 30 minutes. Temperature 66 degrees at noon. Had good day, treated 114 trees. No foliage hurt.

October 22nd—Cloudy and misty; worked until 10.30 a. m., when it began to rain; temperature 60 degrees. Rained until 2 p. m. Trees too wet to work.

October 23rd—Cloudy, windy and misty. Temperature 54 degrees. Rain began 9 a. m., and had to stop work at 9.30; rain all day.

October 24th—Sunday; cloudy, windy and rainy.

October 25th—Raining and very windy and blustery. Temperature 53 degrees at noon; could not work.

October 26th—Cloudy and gentle breeze. Temperature 54 degrees. Good day for work. Treated 100 trees, and stopped work at 5 p. m. No foliage hurt.

October 27th—Cloudy, little wind and no rain. Temperature at noon 55 degrees. No foliage hurt.

October 29th—Rain last night and this morning; began work at 10 a. m.; trees quite wet. Temperature at noon 58 degrees. No foliage hurt.

October 30th—Cloudy, with sun coming out occasionally. Temperature 76 degrees 2 p. m. Foliage hurt when trees were tented during sunshine.

October 31st—Sunday; cold and disagreeable.

November 1st—Rain and blustery; too wet to work. Temperature 58 degrees.

November 2nd—Cloudy, sun shining occasionally. Election day. No work, as laborers were not here.

November 3rd—Cloudy, sun shining occasionally. Temperature 56 degrees. Foliage hurt on some trees.

November 4th--Sun shining part of the time. Temperature 60 degrees. Few trees with foliage singed.

November 5th--Cloudy and sunny. Temperature 62 degrees; work suspended, acid gave out.

November 6th—Clear, a light breeze. Temperature 76 degrees—2 p. m. Foliage hurt on most trees; 120 trees treated.

November 7th—Sunday; fair a. m., rain p. m. Temperature 52 degrees at 2 p. m.

November 8th—Rain and wind. Temperature 56 degrees at noon; began work at 3 p. m., and treated 11 trees and had to stop on account of rain. No foliage hurt, but fear that the gas has not killed all the scales, as the trees were very wet.

November 9th—Rain last night; cloudy during morning, and trees very wet. Temperature 70 degrees 2 p. m. Very windy, and could not handle tents; only 6 trees treated.

November 10th—Cloudy, some wind and cold. Temperature 48 degrees at 10 a. m. Very little work done on account of wind.

November 11th—Cloudy and windy during a. m.; rain during p. m. Temperature 52 degrees, could do nothing during afternoon.

November 12th—Cloudy, cold and very windy. Temperature 48 degrees 10 a. m., could not handle tents at all, too much wind.

November 13th—Cloudy, cold and windy. Temperature 41 degrees at noon; work very slow on account of wind.

November 14th—Sunday; cloudy, cold and windy. Temperature 43 degrees at 10 a. m.

November 15th—Rain last night. Trees very wet this a. m. Temperature 55 degrees at 10 a. m.; began work at about 9 a. m. No foliage hurt.

November 16th—Clear, slight wind. Temperature 56 degrees noon. Some foliage hurt, not much left on trees.

November 17th—Clear, little wind. Temperature 40 degrees at 10 a. m. Foliage slightly singed.

November 18th—Fair, gentle breeze. Temperature 43 degrees 11 a. m.

November 19th—Clear, gentle breeze. Temperature 40 degrees 2 p. m.

November 20th—Clear, but not able to work on account of lack of cyanide, which has been delayed on road.

November 21st—Sunday; clear and cold.

November 22nd—Clear and windy. Temperature 48 degrees at 2 p. m.

November 23rd Cloudy, cold and windy; some snow. Temperature 40 degrees 9 a. m. Could not use tents on account of wind until afternoon.

November 24th—Cloudy, with occasional sunshine. Temperature 40 degrees 9 a. m. Rather cold to work, and little windy; hard to keep tents in place.

November 25th—Clear, cold and cloudy. Temperature 40 degrees 9 a. m. Finished the Bartlett orchard and began the peach in p. m.

November 26th—Rained all the forenoon, cloudy in p. m. Temperature 70 degrees 2 p. m. Continued work on peach trees.

November 27th—Cloudy, sun shining occasionally, and quite windy. Temperature 60 degrees noon, tents weighted down, and left on only 25 minutes. Work completed at 2 p. m.

Annapolis Junction:—I began a series of experiments in a young plum orchard belonging to Col. W. S. Powell, Annapolis Junction, March 17th, 1898. The trees were just coming into bearing and 63 out of 108 were found infested with the scale, many of them being in a very bad condition (See page 36). The buds were just beginning to unfold and the worst infested trees were selected for experimental purposes, and numbered as follows: (Nos. 1 to 4 were sprayed with kerosene and gasoline.):

No. 5. March 17th. Abundance plum 9 feet in height; cloudy and rather windy. Temperature 62 degrees. Time 1 hour, 4 to 5 p. m. Cyande 5 ounces; acid 7½ ounces and water 10 ounces.

No. 6. March 18th. Abundance plum 7 feet in height; cloudy, strong breeze. Temperature 66 degrees. Time 45 minutes, 10.20 to 11.05 a. m. Chemicals 2½-4-6.

No. 7. Identical with No. 6, except time of application, which was from 10.25 to 11.10 a. m. Chemicals 4-6-9.

No. 8. Botankio plum 9 feet in height; cloudy, strong breeze, temperature 68 degrees. Time 45 minutes, 10.35 to 11.15 a. m.

No. 9. Botankio plum 10 feet in height; cloudy, gentle breeze, temperature 68 degrees. Time 1 hour, 11 a. m. to 12 noon. Chemicals 6-9-12½.

No. 10. Botankio plum 8 feet in height; other conditions same as No. 9. Time 1 hour 11 a. m. to 12 noon. Chemicals 3½-5½-8.

No. 11. Abundance plum 8 feet in height; weather conditions same as above. Time 1¼ hours, 11.45 a. m. to 1 p. m. Chemicals 3½-5½-8.

No. 12. Identical with No. 11, except amount of chemicals, 2-3-4½.

No. 13. Botankio plum 9 feet in height; weather conditions same as above. Time 1 hour, 12.10 to 1.10 p. m. Chemicals 2½-3½-5.

No. 14. Botankio plum 10 feet in height; cloudy; temperature 70 degrees. Time 1 hour, 12.15 to 1.15 p. m. Chemicals 4-6-9.

No. 15. Botankio plum 8 feet in height; weather conditions same as above. Time 45 minutes, 2 to 2.45 p. m. Chemicals 3-4½-6½.

No. 16. Abundance plum 7 feet in height; time 45 minutes, 2.05 to 2.50 p. m. Chemicals 3½-5½-8.

No. 17. Abundance plum 9 feet in height; cloudy, calm; temperature 68 degrees. Time 45 minutes, 2.10 to 2.55 p. m. Chemicals 3½-5½-8.

No. 18. Botankio plum 9 feet in height. Conditions same as No. 17. Time 45 minutes, 2.15 to 3 p.m. Chemicals 3-4½-6½.

These trees were closely followed during the spring, and all of them put out their foliage beautifully. April 1st, all the scales examined were dead. April 15th, no live scale found yet; May 1st, no live scale detected after turning 500 on twigs cut from each tree; May 10th, examination made by my assistant, Mr. Sanderson, but no live scale found; May 14th, I examined twigs cut from Nos. 5, 6, 7, 8 and 12, turning 500 scales on each, but found none living. May 26th, I examined twigs cut from Nos. 5, 6, 8, 12 and 16, but found no live insects, while living scales were found on twigs from the trees treated with pure gasoline. Young larvae were also found on these two trees June 14th.

The general outcome of these experiments up to the present time, June 15th, is so far satisfactory. We cannot hope to find a remedy for the San Jose scale that is more efficient than hydrocyanic acid gas. The trees have not been injured in the least, while those treated with kerosene have been seriously damaged.

Euonymus Scale:—The following experiments were made upon Euonymus bushes, *Euonymus americana*, which were very badly infested with *Chionaspis euonymi*, one of the scale insects, very troublesome to these shrubs in the south. The bushes were very old, some of them being 12 feet in height, with a diameter of from 6 to 8 feet. The scale began to make its appearance upon them about six years ago, so far as I can find out, and has been spreading gradually from year to year until every shrub on the place of this variety was infested. Seven of the most beautiful bushes have been killed, and the others so badly infested, it was impossible to see the bark.

The methods used were the same as those in the preceding experiments. It was warm, calm and rather cloudy. All the shrubs and hedge were treated December 16th, 1897.

No. 1. Shrub 10 feet high tented. Used 1¼ ozs. cyanide, 1¾ ozs. acid and 3 ozs. water. Time 30 minutes, foliage not hurt.

No. 2. A duplicate of No. 1, except shrub was 8 feet high.

No. 3. Same as No. 2.

No. 4. Same as Nos. 2 and 3.

No. 5. Very large shrub, tented 9 feet. 2½ ozs. cyanide, 3¾ ozs. acid and 5½ ozs. water. Time 45 minutes.

No. 6. Same size shrub as No. 5; same amount chemicals. Time 40 minutes.

No. 7. These shrubs were about 7 to 8 feet high and very dense, forming a hedge about 30 feet in length. It was very difficult to separate the shrubs, so as to get the tents in place. The chemicals used were roughly estimated, as we had no convenient method of estimating the contents tented.

I examined twigs cut form each of these experiments January 15th, 1898, and was unable to find any living insects. Twigs cut June 4th, 1898, forwarded to me by mail, were examined carefully under a lense, but no trace of living scale could be found on Nos. 1 to 6, inclusive. On No. 7, I found several females and they were alive. This is what I expected, as the conditions under which this hedge was treated, were of such a nature, we were not sure that all the twigs and branches came under the tent. My assistant, Mr. Sanderson, examined the shrubs June 7th, and was unable to find any living scale. The twigs examined by myself, June 8th, were literally encrusted with this scale, but all were dead, except an occasional one on No. 7. It must be noted also that not a leaf was injured on these shrubs by the gas.

From these results, it appears tha Euonymus shrubs infested with Euonymus scale, can be successfully treated with hydrocyanic acid gas without injury to the shrubs, and the complete destruction of the insects.

FUMIGATING NURSERY STOCK.

Owing to the widespread distribution of the San Jose scale, and the demand from fruit growers for a "clean bill of health," many nurserymen are now fumigating with hydrocyanic acid gas everything they grow or handle. Indeed, this is the only safeguard, and affords both the nurseryman and fruit grower a protection not secured in any other way. Fumigation has now become a necessity, and many of our most successful nurserymen have constructed houses for that purpose. There is no longer any doubt about the certainty of this method for the destruction of scale insects, and many other insects that infest nursery stock. In the fall of 1896, I fumigated a miscellaneous lot of trees, direct from the nursery, and badly infested with San Jose scale. These were then set out and watched carefully during the season of 1897, and up to the present time (May 1, 1898), not a living scale has been detected upon any of them. Other experiments were conducted in the spring and summer of 1897, with the most gratifying results. I have had a most excellent opportunity of making a thorough and conclusive test, and after two year's experiments I have concluded that the gas method is the only practical one for nurserymen and dealers. At the same time, it is the least expensive of any of the methods now known, and the generation of the gas is so simple it can be handled by any nurseryman. The only requisites necessary for its successful application are (1), a good, tight tent, box, or house and (2), the chemicals.

Necessary Equipment:—A good tent such as described on page 74, (Figures 17, 18), can be used; but I do not advise it, as the cost would be equal to or in excess of a house of much greater capacity. There are also other objections to a tent; the first is that by constant use it is liable to become torn, and secondly, and most important, the cubic capacity or space enclosed will vary with each lot of stock fumigated. unless a frame is used, and here lies the greatest source of error, as the chemicals, each time, must be weighed, after the calculation of the cubic contents. This danger of error is eliminated when a box or house is used, for it matters not whether one or a thousand trees are placed in the enclosure, the amount of the chemicals to be used remains constant.

The Box:—The size of the box or building to be used, of course, depends upon the amount of nursery stock grown or handled. For my experimental work I have found a box 6 feet long, 3 feet wide, and 2½ feet deep very satisfactory. It is made of common flooring and is double. Inside the boards run the long way, while outside they run cross-wise, which adds strength and stability. It is a simple, plain, open box, and when filled with young trees, kept in place by a couple of slats, it is turned bottom upwards and a little loose earth stamped about the edges. This makes a perfectly gas-proof box, and is all that is necessary for a nurseryman or dealer having a small trade.

Fumigatorium:—A fumigatorium is a house or room constructed or adapted for the fumigation of nursery stock or other materials with hydrocyanic acid or other gases. We have several houses constructed for that purpose, and all Maryland nurserymen are now required by law to fumigate every tree they grow or handle.

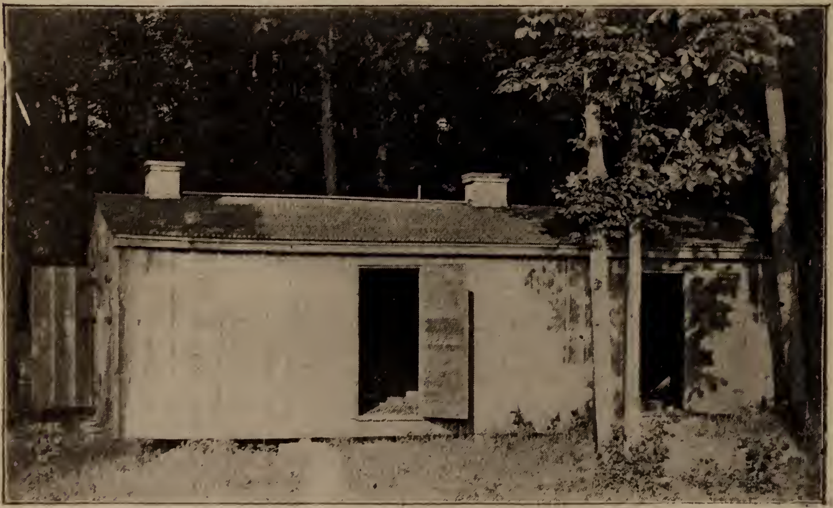

Figure 26.—Fumigatorium, or house for treating nursery stock with hydrocyanic acid gas. Photo by W. G. Johnson.

One of the largest houses in this country, used for fumigating purposes, is shown at figure 26. It is 32x16x8 feet with a roof pitch of two feet, and is divided into two large rooms about 15x14x7 feet and two smaller rooms 4x5x7 feet, constructed as follows:

First, a good, substantial frame is built which is covered outside with 1¼ inch 12-inch Virginia pine boards, and ½x4 inch batting. The interior is first lined with two-ply cyclone paper and then with 4 inch flooring. The partitions and floors are also double with paper between. The roof is covered with heavy roofing paper, tarred and graveled. The doors are 6½x3 feet (3½ feet would be better), made double, refrigerating style, and hung with three heavy strap-iron hinges, and held in place when closed with two bolts. At the top of each large room on the opposite side there is a door 3x2½ feet for ventilating purposes. There is also a flue opening between the rooms as shown in the illustration, which can be uncapped when it is desired to air the house

In building a house of this kind it must be born in mind constantly that it is to be gas-proof, and to accomplish this, no slovenly workmanship is permissable.

A fumigatorium the size of the one just described is sufficiently large for a person or firm handling annually a million or more trees. Where 100,000 or more trees are handled each season, a smaller house containing a single room can be used. A convenient size is from 12 to 15 feet square, and 7 feet high, inside measurements. One even smaller would suffice, depending of course upon the amount of nursery stock grown or handled. In fact, almost any reasonably tight room can be repaired and used; but one must make sure it is gas-tight.

After all, a fumigatorium is not so expensive. When not being used for fumigating purposes, which lasts only a few months in the fall and spring, it can be used for any other purpose, and such buildings are necessary in any well established nursery.

How the Work is Done:—The trees are dug from the nursery and loosely packed in the fumigatorium either on end or flat on the floor. The chemicals are then prepared and properly placed as near the center of the room as possible, after which the doors are closed and left for a half to three-quarters of an hour. A half hour is the minimum limit, but dormant trees are not hurt in the least if left even over night, and it is necessary to do this at times as the house is filled at the quitting hour. After fumigation, the trees are packed for shipment or heeled in on the yards.

I have determined by a long series of experiments this spring (1898), that nursery stock even after the buds have begun to unfold will stand a much greater amount of gas and for a longer time than was formerly supposed. There is not the slightest danger of injuring nursery stock by a single, double, or even treble fumigation.

I have found by experiment that I get the best results when I use

25 grams (a little less than 1 oz.,) (by weight) Potassium Cyanide, 98-99 per cent. pure.

1¼ ozs. (liquid measure) Sulphuric Acid, best grade commercial, (sp. gr. 1.83).

1⅞ ozs. (liquid measure) Water

for every 100 cubic feet of space enclosed. These amounts can be used for every 75 cubic feet if desirable; but, ordinarily, it is not necessary.

The chemicals are weighed, prepared, and used as described on page 77.

Fumigating Buds:—It is very desirable to fumigate all buds, from whatever source they come, before allowing them to be budded into the nursery. By taking this precaution a great deal of trouble may be averted. As an illustration of the importance of this I merely cite one instance. Last summer while inspecting one of our large nurseries, I noticed a box containing some apple buds from a central-western nursery which had been lately received, and, upon examination I found these infested with the San Jose scale. The few scattered scales would have escaped the eye of the nurseryman and would with great certainty have been budded into the nursery, had they not been intercepted. By fumigating, even though they had been overlooked, the scales would have been destroyed.

The process for fumigating buds is the same as for trees, but a special box should be made for the purpose. A convenient sized box for large nurserymen is one 4x2½x2½ feet. It requires .22 ozs. Potassium Cyanide, .33 ozs. Sulphuric Acid, and a trifle over .50 ozs. of water.

A box 2x2x2½ feet is a convenient one for smaller nurserymen; but such small boxes are not desirable on account of the diminutive amounts of chemicals used; for a box this size 2.5 grams cyanide, 3.75 cc. of acid, and 5.62 cc. of water.

A nurseryman can make almost any box perfectly tight by painting and papering. In fact, a label box can easily be converted into a gas-box. Of course the chemicals necessary can be easily calculated when the capacity of the box is known, using .25 grams of cyanide, .37 cc. acid, and .56 cc. of water for every cubic foot of space.

Caution:—It must be remembered that Potassium Cyanide is *one of the most deadly poisons* known, and that nothing is more destructive to animal life when inhaled than hydrocyanic acid gas.

When removing a tent or box care should be taken so as not to inhale the gas. The doors in a fumigatorium in which gas has been generated should be thrown open and allowed to air, at least *10 minutes* before any person is allowed to enter. This is a rule that must be strictly observed, otherwise life is endangered.

A fortunate accident happened in one of our fumigating houses last fall which should be a signal warning to those who may use this gas. The house had been filled with Norway Maple trees and after the usual length of time the doors were thrown open. At the expiration of seven minutes, a negro laborer who had been repeatedly warned not to enter the room under ten minutes, went in and began handing out the trees to another negro who was standing at the door. He handed out two bundles and while stooping for the third, fell headlong on the floor. He was immediately pulled out, laid on his back in the open air, recovered consciousness in about fifteen minutes, and was seemingly as well as ever in half an hour. When asked what had happened and how he felt, he replied, "De Lord only knows dat stuff am a powful axfitter."

It is needless to say that this negro, and no others on the place, have since entered the room under 10 minutes after the doors were opened.

Another peculiar accident happened during our experimental operations at Capt. Emory's. Our cyanide having been shipped to us in lumps too large for use, we found it necessary to break it up in smaller pieces. In order to do this and keep it from flying, we covered it with an old fertilizer bag. After the cyanide had been removed from the bag, and the smaller particles shaken out, the bag was again shaken out the window to free it of any particles that may have remained. As a result, a few very small pieces, not larger than a pin's head, were shaken on the ground. Two fine, large chickens, especially prized by their keeper, roaming about, picked up some of the cyanide, and in less time than it takes to write this account, they were on their backs. One died in a very few moments, while the other recovered, evidently not having gotten so much.

Prof. Woods tells me that a favorite cat, which was asleep under a bench in one of the greenhouses he fumigated, was killed without being awakened. A dog was placed in one of our fumigating houses to test the effect of the gas upon animal life, after the room had been opened and aired for seven minutes, and again closed. The animal was removed after five minutes exposure in an unconscious condition, but recovered in half an hour. Many instances could be cited, but this will suffice our purpose in warning those who use cyanide or hydrocyanic acid gas that they are exceedingly dangerous substances.

EXPERIMENTS WITH OTHER SUBSTANCES.

WHALE OIL SOAP.

Whale oil soap has for a number of years been the standard remedy used against the San Jose scale, and is perhaps to-day the safest and best all-around material for the destruction of this insect upon bearing trees. Professor J. H. Comstock was the first to use this material against scale insects in general, calling attention to it in his annual report as U. S. Entomologist in 1880. The discovery of its efficiency for the destruction of the San Jose scale, however, belongs to Robert S. Emory, of Chestertown, Maryland. In 1892, when Mr. Emory first discovered that there was something wrong with a block of Lawson pear trees, he became alarmed, and thinking the trouble was due to a species of scale insect, he immediately set to work for its destruction. Having a supply of whale oil soap on hand, which he had been using against the pear leaf slug, he applied this material as a winter wash to every infested and suspected tree. He diluted the soap with water to a consistency of thick, soft soap and coated the trunks and larger branches of the infested trees with it. Mr. Emory followed up this treatment the fall of 1893, and by so doing, kept the insect somewhat in check.

In 1894, Mr. Emory called upon Dr. Howard to assist him in checking the further spread of the pear Psylla, which was very abundant in his orchard. It was at the time of Mr. Marlatt's visit, who was detailed to make the investigation, that Capt. Emory called his attention to his treatment of the pear trees infested with scale. At first Mr. Marlatt expressed considerable surprise, stating that he would have been of the opinion that whale oil soap applied in so strong a solution would have destroyed the trees. It appears that Howard and Marlatt began their extensive series of experiments with whale oil soap in Mr. Emory's orchard and in a large peach orchard at Riverside, Charles county, shortly after this conversation. The details of their experimental work are given in Bul. No. 3, n. s. Division of Entomology, U. S. Department of Agriculture. The results of these experiments were very satisfactory, and showed beyond all possible doubt, that whale oil soap, properly diluted, was the best and most satisfactory remedy for the destruction of the scale.

Mr. Emory conducted his experiments with the soap in the fall of 1895, varying his operations somewhat, from the fact that he used a spray pump, instead of applying the material with a brush as formerly. During that season he used over seven barrels of soap, an equivalent of about 2,800 pounds. In the fall of 1896 he again sprayed every tree of the infested block with soap at the rate of from 2¼ to 2¾ pounds in a gallon of water, using in all that season 14 barrels, or about 5,600 pounds. During the fall of 1897 five more barrels, or about 2,000 pounds, were used in spraying the blocks which were not fumigated or treated with other substances.

In view of these facts we can say, without fear of contradiction, that Mr. Emory has had more experience spraying with whale oil soap for the destruction of the San Jose scale than any other orchardist East of the Rocky Mountains or, perhaps, in the United States. I have had an unexcelled opportunity for watching the results of this heroic treatment, and have been given every facility on the part of Mr. Emory for making observations.

Kind of Soaps:—The whale oil soap first used was made with caustic soda, and when diluted with water and sprayed upon trees, left a whitish coating or residue. This soap was also used with some difficulty, from the fact that it became a semi-solid when partially cold, and was sprayed with considerable trouble unless applied while hot.

This difficulty was overcome by having a soap made with potash lye, which could be used either hot or cold. At the meeting of the Association of Economic Entomologists at Buffalo in 1896, Mr. Marlatt stated that most of the brands of whale oil soap on the market were unreliable, and indicated that the soda was much inferior to the potash as an emulsifying agent for insecticide soaps. By request, he had Mr. James Good, of Philadelphia, make a potash soap which fulfilled the requirements, and which was recommended for use by entomologists.

From our experience, however, in Maryland during the fall and winter of 1896, we found it very difficult to get a uniform grade of potash soap. Of the 14 barrels used by Mr. Emory, purchased at three different times, no two lots were of the same uniform consistency and had the same effect when applied to the trees. The first lot was all that could be desired, and answered every purpose very satisfactorily, while the second lot was of a very inferior quality, though sold for the same grade, and when diluted with water, looked more like raspberry juice than the very dark uniform color of the first lot. The third lot was a little better than the second, though not as good as the first. After considerable correspondence with Mr. Good, Mr. Emory ascertained that it was almost impossible to get materials exactly alike for the manufacture of these soaps in large quantities. After this experience, however, we have now upon the market several brands of whale oil soap which meet all our requirements for insecticide work. We have been using "Good's Potash Whale Oil Soap No. 3" in all our experimental operations, and have found it a very satisfactory material. During the last year, the grade has been quite uniform, and we have little or no difficulty with it. We have also tested the "Anchor brand," sold by Leggett & Bro., of New

York City, and found it also very satisfactory. Good's No. 3 soap can be purchased in 275 pound kegs, or 475 pound barrels at from 3 to 3½ cents per pound in Philadelphia. In smaller quantities of from 50 to 170 pounds it costs from 4 to 5 cents per pound.

Application:—Whale oil soap must be diluted with water at the rate of two pounds in a gallon, and applied while hot or lukewarm during the fall, winter or early spring months to get the best results. It must be understood, however, that the soap in this solution cannot be applied to trees in full foliage, as it will destroy the foliage and buds, and seriously injure, if not kill, the trees. It is recommended for a winter treatment, and should be used at the times indicated, when the trees are not in foliage.

In preparing this soap, where one is using large quantities it is necessary to have a large iron or copper kettle, in which the water can be heated, and into which the soap is placed and thoroughly dissolved before being used. It is desirable to have the kettles where the water and the materials are convenient, and at the same time, at some central point in or near the orchard to be treated. Soap diluted in this way can be applied safely to nearly all of our deciduous fruit trees, except peach, usually without injury to the fruit or leaf buds. The fruit buds of peach, on the other hand, are sometimes destroyed by spraying with soap in a two pound solution. It should, therefore, be used cautiously and with care on peach trees, if it is desirable to secure any fruit the following season.

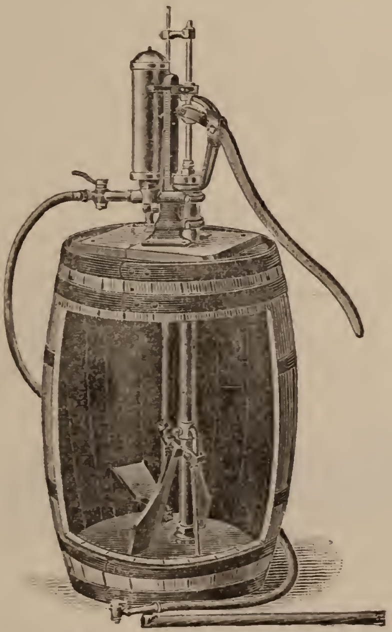

Figure 24.—The Peerless Barrel Sprayer
(After the Deming Co.)

I desire also to state in this place that during Mr. Emory's spraying operations in 1896, where he used the soap at the rate of from 2¼ to 2¾ pounds per gallon, as a consequence, many of the trees were severely injured. Considerable dead wood was cut out the spring of 1897. On the other hand, where the soap was used at the rate of 2 pounds to a gallon, none of the trees were injured.

Apparatus:—In view of the fact that the soap has a softening effect upon leather, spraying pumps with leather valves are not desirable. The most satisfactory and convenient spraying devices, therefore, are those made with metal valves, such as the "Peerless" (Figure 24), manufactured by the Deming Company, Salem, Ohio, or the "Aquapult," made by W. & B. Douglas, Middletown, Connecticut. This latter pump is a very convenient and inexpensive one. An outfit which has been designed and used successfully in a number of our large orchards for some years past, is shown at Figure 25, and I have named it the "Emory Spraying Outfit," from the fact that it was designed and first used by Mr. Emory.

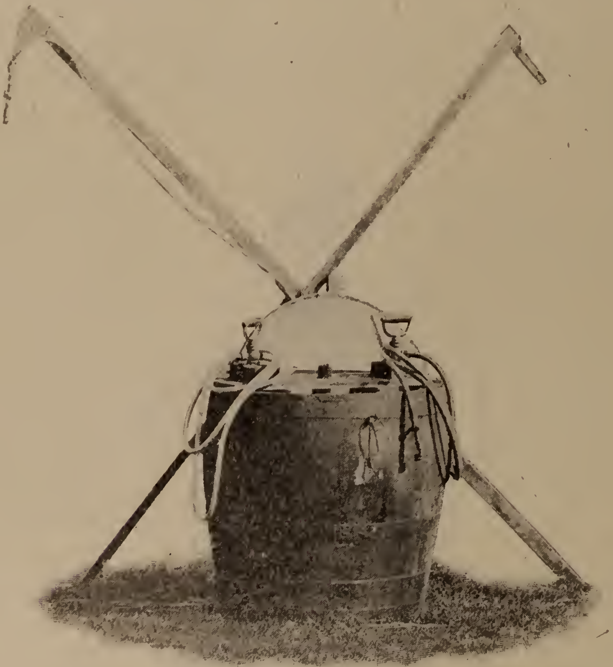

Figure 25.—Emory Spraying Outfit. Photo. by W. G Johnson.

The apparatus consists of one or two Aquapult pumps placed in a barrel, cut to the proper height and covered, as shown in the illustration. These pumps are fitted with a 10 or 12 foot section of one-half or three-quarter inch hose, a stop cock and one Cyclone or Bordeaux nozzle. The entire cost of one of these pumps, with hose, nozzle, etc., is about five dollars. Of course, where two pumps are used in the same barrel, the cost would be double, but for ordinary purposes, one is all that is necessary. The barrel is placed in a wagon or cart, and one man can operate it successfully by pumping with one hand and spraying with the other, directing the spray upon the trees with the pole connection, as shown in the figure.

Until we find a better remedy to be applied as a spray for the destruction of the San Jose and other scale insects, we shall continue to recommend the use of whale oil soap at the rate of 2 pounds to a gallon of water, applied during the dormant condition of the trees.

NEW SOAPS.

After some correspondence with W. S. Powell, President of the Powell Fertilizer and Chemical Company, Baltimore, Md., I succeeded in getting two soaps, designated Nos. 1 and 2, made as follows:

No. 1.—A mixture of mineral oil, fish oil and sulphate of potash, containing of the latter about 35 per cent. It was believed that the mineral oil used would have better solvent properties than the fish oil heretofore used in making whale oil soap.

No. 2.—Was made of foots, that is, the residue after pressing the oil out of fish chum with sulphate of potash, making a soap containing aproximately 50 per cent. of sulphate of potash.

A young apple orchard, located near Brookville, Montgomery county, belonging to James B. Hallowell, and slightly infested with the San Jose scale, was selected for the purpose of making the experimental tests with these soaps. Six apple trees, about six years old, quite badly infested with the scale, were selected, and the soaps were used at the rate of 1, 1½ and 2 pounds per gallon, and applied May 18th, 1897, when the trees were in full foliage. The experiments were as follows:

No. 1—Soap No. 1.—May 18, Albemarle pippin apple, moderately infested with the San Jose scale, treated with 12 quarts of spray diluted at the rate of 1 pound to a gallon.

No. 2.—Same as No. 1, except that the soap was diluted at the rate of 1½ pounds in a gallon of water.

No. 3.—Duplicate of Nos. 1 and 2, except that the soap was used at the rate of 2 pounds in a gallon of water.

Twigs cut from the preceding experiments were examined June 10, 1897, and we found that the foliage had been injured slightly on the one pound dilutions, and very severely where the two pounds were used. At the same time, one living female scale was found. July 15th another examination was made, and we determined that about 5 per cent. of the insects were living, while the foliage had been damaged considerably. At this time also, a considerable number of young larvae were found crawling over the trees.

No. 4.—May 28th. Fall pippin. Soap No. 2. 1 pound to a gallon of water, 12 quarts of spray used on tree.

No. 5.—Albemarle pippin moderately infested, sprayed with 6 quarts diluted at the rate of 1½ pounds in a gallon. No. 6.—Fall pippin sprayed with 6 quarts diluted at the rate of 2 pounds to a gallon. Tree very badly infested, the branches and twigs being literally covered.

Twigs cut from experiments Nos. 4, 5 and 6 were examined May 28th, and we found that fully 90 per cent. of the insects were living, and that the foliage had not been injured.

Other examinations were made June 10th and July 15th with the same results, at which latter date the young larvae were very abundant and crawling. From these experiments, it appears that soaps made according to the above formulas cannot be used to advantage for the destruction of the San Jose scale. While soap No. 1 was fairly satisfactory, the injury to the foliage was such that we could not recommend it for general use during the spring or summer. On the other hand, soap No. 2, while not effective in destroying the scale, also has other objectionable features, in that it must be applied when quite hot, otherwise it solidifies readily, stopping up the hose and nozzle. Up to the present time, we have found no soap as effective as a good quality of potash lye whale oil soap.

PURE KEROSENE ON YOUNG AND BEARING TREES.

Our experience with pure kerosene is such that we cannot recommend it for spraying either young trees or bearing trees in the orchard, unless done under our own personal supervision. The work of Messrs. Marlatt and Coquillett, of the Division of Entomology, United States Department of Agriculture, on bearing peach trees in Charles county, this State, during the winter of 1894-95 was of such a nature that it was not thought expedient at that time to continue the experiments with pure kerosene or undiluted kerosene emulsion, as all the peach treated with these substances were killed (Bul. No. 3).

Later experiments, notably by Messrs. Webster, Marlatt, Smith, Alwood and myself show conclusively that the physiological effect upon the plant varies with the kind of tree, and upon the time and manner in which the application is made.

After Mr. Marlatt summarized the results of his later experiments with pure kerosene in a paper before the Association of Economic Entomologists at Detroit, in August, 1897, he says: "These results are so greatly in contrast with those previously attained in the experiments conducted in practically the same way, that it seems difficult to account for them. That spraying with pure oil will often kill trees cannot be doubted, even when applied in the dormant condition in winter, as demonstrated by experiments on a number of apple and peach trees two or three seasons ago. It is possible that with these earlier experiments, the same care was not employed to prevent the collection of oil about the trunks of the trees, and the trees were not mounded up, but the work was as carefully done as would ordinarily be the case in actual practice, and probably much more so. It is possible, therefore, that the death of these trees in some instances, was due to the collection of the oil in the cavity formed about the trunk by the swaying of the trees in the wind, which as will be shown later, has had disastrous results in California with the emulsion even. Others have reported the use of oil on trees without injurious effects in some instances, and in others with injurious effects, so that pure oil as an insecticide is one to be used with full appreciation of the fact that the death of the plant may result."

A partial summary of the results of Prof. Alwood's experiments, conducted in March, 1897, was published in Bulletin No. 72, Virginia Station, in January, 1898. He related that he believed that pure kerosene could be safely used on all the hardy fruit trees, but, fearing serious results, he was not willing to recommend it in the hands of untrained persons.

In a later publication (Bul. No. 74, Va. Sta.) received May 1st, 1898, Prof. Alwood records a number of experiments made by him in March, 1898. Giving the results of this work up to April 22nd, he says: "The foregoing abstracts and unpublished matter in the records of the work now in progress show that pure kerosene can be safely used upon all our fruit trees in the dormant season. and with proper precautions during the growing season also. The chief point to be observed in its application is the proper atomization of the kerosene. Unless it be applied in a finely atomized condition, and in quantity so as to just moisten the parts of the plant, there is danger. The skill and judgment necessary to insure safety in this work are not such as to preclude the use of kerosene by fruit-growers, hence, in the light of the above, and other unpublished experiments, I recommend it as a summer treatment for the San Jose scale. I believe it to be the treatment *par excellence*, as in every case where I have used it on this scale, it has destroyed them with great certainty. It is too soon to make an absolute statement as to the degree of efficiency, but the experiments now under way will furnish much data on this point by the end of the season."

The outcome of the carefully prepared series of experiments by Professor Webster. recorded in Bul. 81. Ohio Station, was very different from the results obtained by Professor Alwood. Professor Webster's experiments were conducted in March. 1897, upon pear, apple, peach, plum, and cherry. The kerosene was applied in a fine spray and with a brush. Out of 23 trees treated. 14 were either killed or seriously injured. Of 6 peach trees. 4 were killed and 2 greatly injured. Reviewing his experiments, Professor Webster says: "Judging from all the information we have gained, it seems that kerosene cannot be safely used on peach trees, or on plum trees of tender varieties, but that, if applied lightly, with a brush to the more hardy plums. pears and apples, especially the latter, it can be used safely. especially if trees are cut back to trunks and bases of limbs."

The results obtained by the experiments of Prof. Smith in 1897, were of such a nature, that he issued a circular September 1st, 1897, advising the use of pure kerosene. He was of the opinion that summer applications would be more effective than winter treatment. and placed much emphasis upon a thorough spraying of bearing trees with kerosene in September, printing the following sentence in large type: "Spray thoroughly in September all infested bearing apple, pear, plum and peach trees with undiluted kerosene during the middle of a clear sunshiny day." It was further stated that if the tree was covered with the finest possible spray, wetting every part of the plant, one application would be sufficient.

In January, 1898, Professor Smith issued Bul. 125, N. J. Station, in which he further recommends the use of pure kerosene, stating that, "it (kerosene) has, however, been also proved, that with proper care and attention, the oil can be safely used on fruit trees, dormant or active, and that it will kill all the scales with which it comes in contact. In fact, my results are such, that I am not sure that it is not safer to use the oil on tender trees like peach when active, than when dormant."

Further on, Professor Smith says: "The essential points to be regarded, in the application of kerosene are the finest possible spray, the completest and thinest possible coating over the entire surface, and weather conditions favoring rapid evaporation. The trees themselves should be dry. Any departure from these suggestions may cause injury, for I wish it distinctly understood that kerosene improperly used, is fatal to plant life."

In Bulletin No. 12, Dr. L. O. Howard, U. S. Entomologist, reviews the experiments made with pure kerosene in various places, and cites an instance where one of his North Carolina correspondents had been prompted to use pure kerosene upon a newspaper recommendation, in September, 1897, and had lost 90 per cent. of the trees sprayed in his 400 acre peach orchard. Dr. Howard says: "It is from such experience as this that we have decided not to recommend the pure kerosene spray as the result of any one's experience, without first advising the individual fruit grower to experiment in a small way and determine for himself by experience in his own locality and under the local conditions which exist there, whether he can use kerosene to advantage." Dr. Howard says, that if he were a fruit grower, he would experiment for himself with pure kerosene and base his conclusions on his own individual results.

The Farmers' Review, May 28th, 1898, contains a note from their stenographic report of the Illinois Horticultural Society Proceedings, bearing on this topic. In reply to an inquiry regarding the San Jose scale, Mr. Morrill, one of Michigan's largest fruit growers and also a manufacturer of spraying apparatus said: "A year ago at this convention we heard men tell of spraying coal oil on trees and not hurting them, and it looked as if it was not harmful. Sometime after that we got an order for special nozzles made very small so that they could be used for spraying with coal oil. We made them so small that they would only throw a mist. We wrote the people who had ordered them that we believed they would kill every tree sprayed with kerosene. They replied that it did not make much difference, as the trees were no good as they were, and they would try the kerosene anyway. I saw a man from that locality recently and he said they had killed 30,000 peach trees by the spray."

RESULTS IN MARYLAND.

After reviewing all the experiments in Maryland, I state most emphatically that pure kerosene sprayed even in the hands of an expert and in the most careful manner possible, with favorable weather conditions, is a dangerous substance to the vitality and life of young and bearing trees. In all the experiments conducted in this state with pure kerosene on bearing trees, the tree has either been killed or injured, or the fruit buds have been killed.

The most disastrous results are recorded in experiment No. 5, where a block of beautiful nine year old Buffum pear trees were destroyed. Capt. Emory, who is a very careful student of current literature bearing upon fruit culture, was prompted to spray the entire block of 400 trees with pure kerosene upon the recommendation made in Bul. 125, N. J. Station, which he received in January, 1898. When asked my opinion regarding this treatment, I strongly urged Capt. Emory not to spray the entire block, but to limit his spraying to half a dozen trees and see the results. Instead of using a few trees, 132 were sprayed as noted under the experiments. The results were so conspicuous, I desire to call the attention of my constituents to figure 21, which shows one of the sprayed trees reproduced from a photograph taken by myself May 24th, 1898. As companions to this, I have reproduced also one of the trees in the same block which had been sprayed with whale oil soap, Figure 22, and one that had the top killed and which had been trimmed back, Figure 23. This ocular demonstration ought to be sufficient for the most skeptical. Capt. Emory assures me that had it not been for my appeals to him not to spray with kerosene, he would have killed his entire orchard, and thus lost several thousand dollars, as the trees are now laden with fruit. It is needless for me to say that this experience is sufficient for one of Maryland's largest and most successful fruit growers, and that he is now thoroughly convinced that pure kerosene "sprayed during the middle of a sunshiny day," in the "finest possibel mist," in the hands of an expert, is surer death to certain trees than the San Jose scale.

On the other hand, a block of thirty year old Duchess sprayed with kerosene at the same time, and under the same conditions, were not killed, as noted under experiment No. 6, but at the same time all of the fruit buds were killed, and the development of the foliage retarded. So serious is the damage to the fruit in this block, Capt. Emory asserts, that he could take the difference between a total failure and half a crop, as is the case with trees fumigated and sprayed with whale oil soap, and buy enough cyanide or whale oil soap to treat his entire orchard.

In every instance on bearing trees, whether sprayed the "middle of a September sunshiny day," in mid-winter or spring, from 80 to 100 per cent. of the fruit buds have been killed, and the vitality of the tree more or less affected, if not killed. With young trees, especially peach and plum, and in all cases with pear and apple, the growth has been retarded.

Our experience with pure kerosene emulsion, and kerosene emulsion diluted in various ways, and kerosene mechanically mixed with water, are such that we cannot at present, make any general recommendations, other than this suggestion, that it will be good policy to use kerosene in any form cautiously.

Summing up these results, it seems certain, (1)—That pure kerosene cannot be safely recommended in this state as a spray for young and bearing fruit trees at any time of the year; (2)—That very old trees of certain varieties, such as Duchess pear, resist the destructive effects of pure kerosene more than younger bearing trees, such as Buffum pear, a condition no doubt, due to the fact that the wood of the very old varieties is firmer and more mature, thus resisting the penetrating properties of the kerosene; (3)—That from 80 to 100 per cent of the fruit buds are killed on bearing trees, whether sprayed in the fall, mid-winter or spring; (4)—That young trees, especially peach and plum, are seriously injured or killed; (5)—That pure kerosene emulsion or kerosene diluted in any

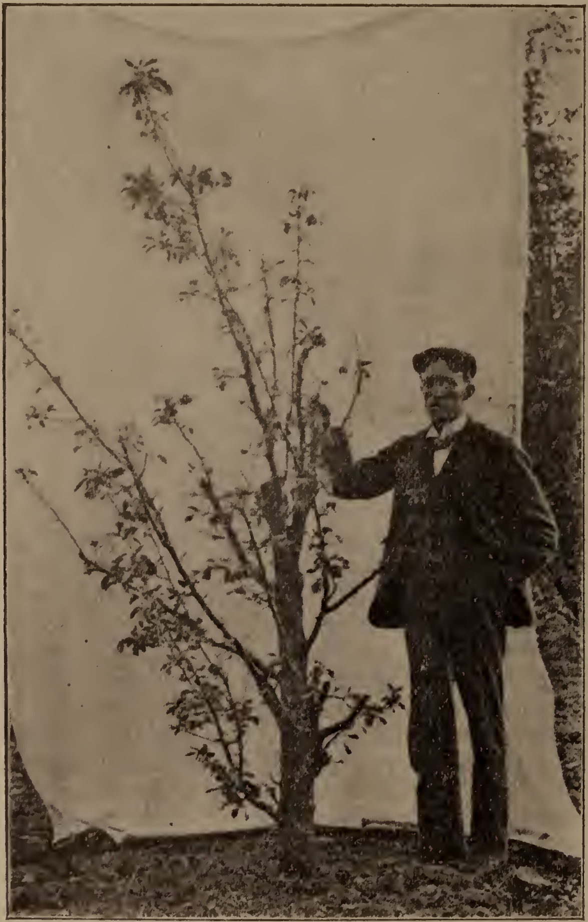

Figure 23.—Buffum pear tree, cut back after spraying with pure kerosene. Photo. taken May 24, 1898, by W. G. Johnson.

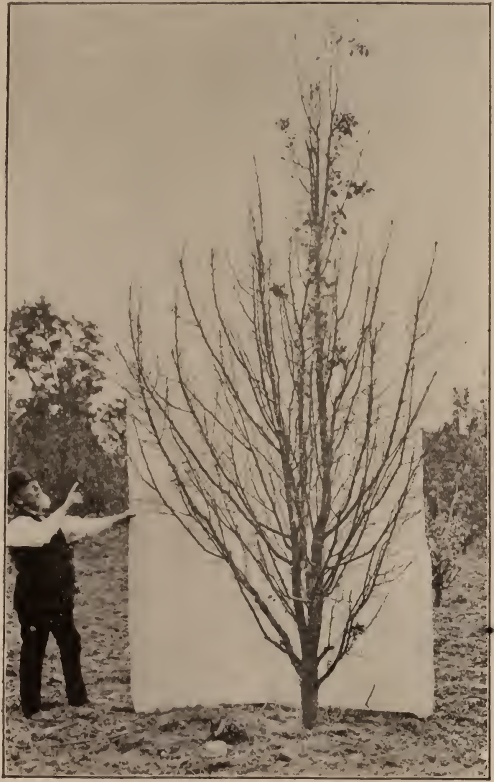

Figure 21.—Buffum pear tree killed by spraying with pure kerosene. Photo. taken May 24, 1898, by W. G. Johnson,

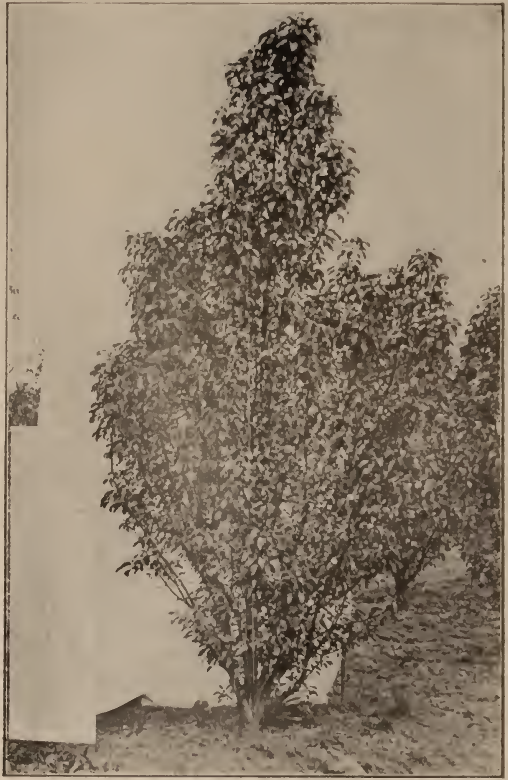

Figure 22.—Buffum pear sprayed with whale oil soap. Photo. taken May 24, 1898, by W. G. Johnson.

form, cannot be safely recommended until further experiments are conducted.

From what I have seen of the effects of pure kerosene upon fruit trees, my final advice to the peach and pear growers, especially, of Maryland, is this, *beware of mineral oils.* If you desire to use pure kerosene, first try it upon a few trees, and decide for yourself whether or not you think it safe to continue the practice.

Pure Kerosene:—The four following experiments were performed in the pear orchards of R. S. Emory, at Chestertown, Kent county.

No. 1. November 6th, 1896, a six year old standard, Bartlett pear tree, badly infested with San Jose scale; sprayed during the middle of the afternoon; sun shining; strong breeze. Tree 16 feet in height; 6 quarts kerosene, 175 degree test used. Tree sprayed from three sides. November 19th, a little less than 20 per cent. of the scales living. The wind carried a fine mist of kerosene, so that it covered one side of a dwarf Bartlett in an adjoining row. The entire side of this tree was killed and cut away. November 24th, tree sprayed with whale oil soap, 2 pounds to a gallon of water. April 16th, buds beginning to unfold. Some little dead wood on young twigs. May 23rd, full foliage, no fruit, dead wood all cut out. August 27th, a few old females, and many larvae seen crawling about the tree. October 14th, about the same number of living scales as on any neighboring tree.

No. 2. A six-year old dwarf Bartlett pear tree in good condition about 10 feet high, and moderately infested with San Jose scale, selected and sprayed with three quarts kerosene at 11 o'clock September 30th, 1897. Temperature, thermometer hanging in tree, 74 degrees F.; sun shining brightly; gentle breeze stirring. Sprayed by myself from three sides. October 14th, leaves a little more yellowish than on surrounding trees. Foliage apparently not seriously damaged. October 28th foliage all off. Leaves dropped several days before those on surrounding trees. March 29th, 1898, Capt. Emory writes that 99 per cent. of the fruit buds have been killed, while the leaf buds seem to be alive; but very much retarded. May 5th, I examined the orchard and found the tree in full foliage, but fully 99½ per cent. of the fruit buds killed. Only an occasional fruit bud on extreme tips in top of tree. Trees surrounding set full of fruit. Could not find any living scale.

No. 3. Tree similar to No. 2, about same size, and moderately infested. Sprayed with three quarts kerosene at 5.30 o'clock p. m., September 30th, 1897. Temperature 70 degrees. Gentle breeze. October 14th, foliage practically all on and green; drops readily when tree is shaken; but not so easily as in No. 4. No living scale observed. October 28th, foliage all off; one living scale found. March 29th, 1898, Capt. Emory reports 99 per cent. of fruit buds killed, and leaf buds greatly retarded. May 5th, I find the tree in full foliage, but considerably less than on surrounding trees. Fruit buds practically all killed. Only an occasional one on extreme tips of topmost branches. Found no live scale.

No. 4. Tree similar to Nos. 2 and 3. Sprayed with three quarts of kerosene October 1st at 6.30 a. m. Temperature 64 F., gentle breeze. October 14th, foliage practically all on, but falls very easily when shaken.

Found no living scale. March 29th, 1898, Capt. Emory reports that fully 75 per cent. of the fruit buds are killed. May 5th, I found the tree in full foliage, but not so dense as on surrounding trees. Fruit fairly well set on the east side and on terminals. Found no living scale.

This tree was also treated with hydrocyanic acid gas October 16th, 1897, for half an hour, with 1¾ ozs. cyanide, 2 ozs. acid, and 5 ozs. water. With this double treatment, fully 75 per cent. of the fruit buds were killed. I will not attempt to explain the cause of this condition, as there are too many factors to be considered, and a general conclusion or deduction would be misleading.

The two experiments next reported were performed by R. S. Emory in his orchard the middle of January, 1898.

No. 5. A block of 400 Buffum pear trees about eight years old and in their prime, were slightly infested with the scale. Desiring to check its further spread in this orchard, Capt. Emory decided to spray the block with pure kerosene, having seen the recommendation of Dr. Smith in Bulletin No. 125. Not being at all certain about the effect of this treatment upon bearing trees, especially when applied in mid-winter, I advised Capt. Emory not to spray the whole block, but limit his experiment to a few trees, and first see the physiological effect. A barrel of 150 degree test kerosene was procured and applied the middle of January during a bright, sunshiny day. 132 trees were sprayed by an expert. An aquapult spray pump, fitted with a cyclone nozzle having a very fine bore was used.

It was apparent a few weeks later the kerosene had seriously injured the trees. The wood of the last two years growth was black. I visited the orchard May 5th, and found nearly all the trees dead. Several of them had a few leaf buds starting here and there among the larger branches, but a more sickly, desolate lot of trees I never saw in my life. It was all the more striking on account of the fact that the trees which had not been sprayed, were in full foliage, and stood out in bold contrast for comparison. Possibly some of the sprayed trees can be saved by cutting them back to the stumps, as there are a few that seem to have some life.

No. 6. In this experiment, the trees selected were in a block of twenty-five year old dwarf Duchess pears. The spraying was done in a similar manner to that described under No. 5, and under the same conditions. The same amount of kerosene was used, that is, three pints to a tree. No dead wood was observed after the treatment, and from the general appearance of the trees May 5th, they had not been seriously damaged by the treatment, so far as wood was concerned; on the other hand, however, all the fruit buds had been killed, while the trees on one side sprayed with whale oil soap, and on the other side not sprayed at all, were set full of fruit.

The two following experiments were conducted near St. Margaret's, Anne Arundel county, in the orchard of A. A. Stinchcomb. An apple and plum tree about five years old, and badly infested with the San Jose scale were selected for the purpose.

No. 7. An apple tree sprayed with two quarts of pure kerosene March 3rd, 1898. Weather cold and sun shining. Strong wind from northwest. The foliage was greatly retarded upon this tree; but it has made a feeble growth. No living scale has been found upon it.

No. 8. A plum tree sprayed on same date as No. 7 with two quarts of kerosene under similar conditions. This tree started a feeble growth of foliage which shriveled up and died about June 1st.

The three experiments which follow were conducted at College Park upon young trees set out one year ago this spring, and all were in excellent condition.

No. 9. Two peach trees with blossoms just ready to open, each sprayed at noon March 17th, 1898, with one pint of kerosene 170 degree test. The sun was shining brightly and a gentle breeze blowing. March 28th, a terminal blossom open. None open on check trees. Petals a little brownish. Buds seriously hurt. March 30th, only fourteen blossoms open on sprayed trees, while checks are in full bloom. Petals and buds all hurt. Smaller twigs turning black, wood evidently hurt. April 15th, fruit buds all killed. A few leaf buds beginning to show themselves on the main stem. Small twigs black and dead. Trees seriously hurt. Two other peach trees same age and sprayed at same time, with whale oil soap, two pounds to a gallon of water not damaged. Both in full foliage; there is no fruit, but there is none on the checks, a condition due, probably, to the severe cold snap and snow storm April 4th and 5th. May 1st, trees still alive, but with only a few clusters of leaves upon the trunk. May 15th, growth shooting rapidly from trunk. Smaller twigs and branches dead. Checks making a beautiful growth.

No. 10. One Abundance plum tree sprayed with a pint of kerosene same day and same conditions as No. 9. The leaf buds were well unfolded. March 28th, buds shooting rapidly. March 30th, few clusters of blossoms out to-day. Leaves rather thin. April 15th, leaves slowly developing. Tree, same kind, sprayed with two pounds of whale oil soap making a good growth. May 1st, foliage on sprayed tree growing, but slowly, and leaves are scattering. May 15th, tree greatly dwarfed, although the foliage is recovering. Tree sprayed with soap fully one-third larger at this time.

No. 11. A Garber pear tree sprayed same as Nos. 9 and 10, with one pint of kerosene under similar conditions. Five others sprayed same day with whale oil soap two pounds in a gallon of water, and two trees left as checks. March 30th, buds about ready to open. April 15th, leaf buds opening on all the trees: but less conspicuous on the tree treated with kerosene. April 30th, leaves well out and tree making good growth, except the one sprayed with kerosene. On this, the buds are retarted and slowly unfolding. The foliage is not as dense as in the other trees. May 15th, tree in fairly good condition, but with only about two-thirds as much foliage as on other trees. No dead wood. There were no fruit blossoms on any of the trees.

The tree selected for the following experiment was a bearing tree planted the fall of 1893, in the orchard of W. S. Powell, Annapolis Junction.

No. 12. An Abundance plum tree very badly encrusted with the scale, with the leaf buds unfolding, was selected for this purpose, and sprayed during the middle of the afternoon of March 17th, 1898. Bright sunshine, and gentle breeze. April 10th, leaves very badly hurt, few young twigs killed. Tree trimmed next day after being sprayed. No live scale found May 10th, foliage considerably hurt; very thin as compared with trees treated with gas and whale oil soap. No fruit set. A microscopic examination of the scales on twigs cut from the tree show that all are dead, so far as can be determined at present.

Kerosene Diluted:—In the following experiments, I used kerosene emulsion (½ pound soap, 1 gallon water, 2 gallons kerosene), pure and diluted. All the trees were moderately infested with scale.

No. 13. November 6th, 1896, a five year old dwarf Bartlett pear tree about ten feet high selected and sprayed with six quarts of kerosene emulsion undiluted. It was put on hot, and the tree was sprayed from three sides. An examination November 19th showed that a considerable number of the scales were still living and the tree was resprayed November 24th, with whale oil soap (two pounds solution). The tree was uninjured on account of the treatment, and was set as full of fruit as any in the adjoining rows.

No. 14. A tree adjoining and similar to that used in No. 13 was sprayed same date with equal parts of kerosene emulsion and two pound solution of whale oil soap. Six quarts of the mixture used. Results similar to those obtained in No. 13.

No. 15. Kerosene emulsion diluted with equal parts of water, and then combined with equal parts of whale oil soap, two pound solution, and sprayed upon a tree similar to those used in Nos. 13 and 14, using six quarts of the combined mixture. Results not unilike those obtained in Nos. 13 and 14.

The three following experiments were made in the orchard of A. A. Stinchcomb, St. Margarets, Anne Arundel county. All the trees were from five to six years old and badly infested with the scale. The spraying was done with a success kerosene sprayer, and cyclone nozzle with very fine opening. The day was cold and blustery.

No. 16. An apple tree ten feet in height sprayed with fifty per cent. kerosene and water March 3rd, 1898. About two quarts of material used. Tree made fairly good growth early in the summer, and has not been much injured. No living scale has been found.

No. 17. A plum tree about eight feet in height sprayed as No. 16, with fifty per cent. kerosene and water, on same date. This tree made a fair growth early in May; but the leaves shriveled and dried up in June. The effect was about the same as when pure kerosene was used.

No. 18. Two apple trees about seven feet in height sprayed with 40 per cent. kerosene March 3rd. Foliage not hurt and the trees have made a good growth. No living scales have been detected to June 1st.

No. 19. A plum tree at Annapolis Junction, about the same size as the apples used in No. 18 sprayed March 17th with 50 per cent. kerosene and water. An examination April 15th shows that the foliage has not been hurt. No living scale found. May 10th, foliage in good condition. A microscopic examination of five hundred scales shows not one alive. May 26th, an examination of the tree shows the foliage in good condition. No living scale found.

GASOLENE.

In March, 1898, I began an experiment at Annapolis Junction with pure gasolene to test the effect of the substance upon the San Jose scale and the physiological effect upon the opening buds.

Two Abundance plum trees badly infested with the scale were selected and sprayed as follows:

No. 1. Abundance plum about ten feet high with buds just unfolding spraying March 17th, 1898, with 3 quarts pure gasolene; the spray was directed from three sides, and the tree thoroughly covered.

No. 2. Abundance plum about same size as the preceding, sprayed with 3 quarts of a 50 per cent. solution of gasolene and water.

An examination of twigs cut from these trees May 14th showed that 62 per cent. were living on No. 1 and 78 per cent. on No. 2. The foliage and buds were not damaged. These trees were sprayed with 20 per cent. solution of kerosene and water May 26th; but young larvae were found crawling June 7th and both trees fumigated with hydrocyanic acid gas June 8th for ten minutes which was not long enough, and again June 16th for thirty minutes. No living scale could be found upon twigs examined June 29th.

From this one experiment it would appear that gasolene pure and diluted can be used upon plums when buds are opening without injury to the tree, but that it destroys a very small percentage of the scale.

NURSERY INTERESTS IN MARYLAND.

It has been part of my official duty as State Entomologist to inspect the nurseries of Maryland, paying especial attention to the general healthfulness of the stock grown in them each season. In every instance, where we have found anything, whether it was insect or disease, which we considered dangerous and injurious in the nursery and orchard, we have put forth every effort to subdue it, and when necessary, have destroyed the trees to accomplish that end.

It is due to our nurserymen that I should say in this place that they have done everything possible on their part to co-operate with me in this work, and many of them have rendered me much personal and valuable assistance. Several insects and diseases of a very serious nature have been detected in large blocks of nursery stock, and in some instances, it has necessitated the destruction of entire blocks: while others have been saved by the application of well known remedies, depending of course, upon the nature of the attack. In every instance where the San Jose scale was found we have had the trees destroyed by burning.

The nurseries, on the whole, are at present in fine condition and growing a beautiful lot of stock. I can see a marked improvement in two years in methods of culture and care in the selection of lands adapted to the growth of young trees.

We have within Maryland 41 nurseries, and a number of small concerns which we have not included in our list. These nurseries had for their fall of '97 and spring of '98 trade, 3,773,845 fruit trees, and 1,221,750 ornamental and miscellaneous plants, of smaller fruits 20,478,075, making a total of 25,888,670. This does not include asparagus roots, of which there were 1,000,300. In these nurseries, there were 2,952,750 peach and 264,000 June buds, 759,300 apple, 94,100 pear, 169,680 plum, 5,100 June buds; 26,525 cherry; 7,390 quince; 331,750 ornamentals; 890,350 miscellaneous stock; 19,178 strawberries; 17,350 currants; 706,300 pears; 312,600 raspberries; 197,900 grapes and 65,925 gooseberries.

In this connection it is also interesting to note that these same nurseries have for sale this fall, (1898), and next spring 5,148,350 trees. Of these, 3,667,500 are peach, 700,050 apple, 80,200 pear, 24,500 plum, 40,000 cherry, 4,750 quince, 151,350 ornamentals and 480.000 miscellaneous trees. Aside from these, there are over 22,000,000 plants of small fruits, including strawberries, grapes, raspberries, blackberries, currants, and gooseberries. These figures do not include asparagus roots, of which there are more than 1,000,000 grown and sold annually.

All the nurseries in this state are now under the immediate supervision of the State Entomologist and State Pathologist and are inspected every six months in accordance with the new law passed at the last session of the General Assembly. (Laws 1898, Chapter 289). By this system of semi-annual inspection and the fumigation of all buds and trees grown or handled, the nurserymen of this state can give their customers a guarantee not given by any other state.

Originally, five nurseries in the state were found infested with the San Jose scale, and by the prompt and immediate destruction of all the infested trees, and a careful suppervision of all the stock handled since then, we have completely suppressed it. This was accomplished, however, only by the hearty and cheerful cooperation I received from the nurserymen themselves. By the total destruction of nearly 38,000 trees in two years, we do not now fear the San Jose scale in our nurseries, for we intend to keep them free from it in the future by constant fumigation and semi-annual inspection.

We will not accept trees or buds from any source outside the state unless they are accompanied with the proper certificate of inspection. The scale is so widely distributed and has been found in so many nurseries, we believe this is the only policy we can pursue at present. In Virginia, according to Prof. W. B. Allwood, State Inspector (First Ann. Rept. 1896-97, pp. 11 and 12), the San Jose scale has been found in 9 nurseries out of 35 inspected. This, so far as I am aware, is the largest proportion of infested nurseries in any state inspected up to the present time. It is reasonable to suppose, that the scale exists in many nurseries, unbeknown to the nurseryman, in states where inspection laws are not in vogue, and for this reason we must have the right to inspect, condemn or destroy trees coming from doubtful sources, as this is our only means of security.

I append herewith a list of our nurserymen, indicating the specialties of each:

MARYLAND NURSERYMEN.

W. F. Allen, Salisbury, Wicomico county. Specialty, strawberries and blackberries; one of the largest growers of these plants in the state.

E. A. Bageley, Bageley, Harford county. Dealer in general nursery stock.

Geo. Balderson, Colora, Cecil county. General dealer.

John S. Barnhart, Denton, Caroline county. General Dealer. Specialties, peach, plum, and grapes; the largest grape grower in Maryland.

William Corse & Sons, Baltimore. General dealers; Specialty, ornamentals, peach, plum, pear and apple.

F. T. Covey, Catonsville, Baltimore county. General dealer; specialty, ornamentals, grows no fruit trees.

Franklin Davis Nursery Company, Baltimore. General dealers; the largest individual growers of nursery stock in the state; specialties, apple, peach, pear, plum, ornamental and strawberries.

Samuel H. Dayhoff, Ringgold, Washington county. Small grower of peach, plum and quince.

Thomas F. Diffendal, Smithburgh, Washington county. Specialty, peach; grows also apple, pear and plum.

Fleming & Hetzer, Williamsport, Washington county. General dealers, growing small lots of peach, apple, pear, quince, and ornamentals.

E. Fogle, Philo, Washington county. Specialty, strawberries.

Robert L. Gulick, East New Market, Dorchester county. Specialties, strawberries, blackberries and grapes. Has extensive variety tests.

J. W. Hall, Marion Station, Somerset county. Specialties, strawberries, blackberries and raspberries.

J. G. Harrison & Sons, Berlin, Worcester county. These gentlemen are the largest peach growers in the state, and rank second as strawberry growers. They are also general dealers in other nursery stock.

John Hoover, Cavetown, Washington county. Small grower of peach and plum.

Horticultural Supply Company, Mountain Lake Park, Garrett county. Small growers of apple, pear, plum and ornamentals.

Chas. E. Jarrell & Son, Hillsboro, Caroline county. Growers of general nursery stock; specialties, peach and plum.

Charles W. Johnson, Ellerton, Frederick county. Small growers of peach. apple and quince.

J. W. Kerr, Denton, Caroline county. Grower of general nursery stock; specialties, plum, peach and apple. Mr. Kerr is considered our best authority on plum, and has one of the largest experimental test orchards of the various varieties of plums in this country, if not in the world.

Daniel Krouse, Wolfsville, Washington county. General grower; specialty, peach.

J. S. Linthicum. Wellhams, Anne Arundel county. General grower of small fruits: specialties. strawberries. blackberries and raspberry. The most extensive grower of raspberries in the state.

Wm. McBride, Vienna, Dorchester county. Grower of general nursery stock.

Theo. J. Myers, Pleasant Valley, Carroll county. Small grower of apple.

W. E. Myers, Hanesville, Kent county. Small grower of peach and plum.

R. G. Nicholson, Chestertown, Kent county. General grower of nursery stock; specialty, peach; large grower

W. M. Peters' Sons, Wesley and Ironshire, Worcester county. Very large growers of general nursery stock. These gentlemen are the second largest peach growers in the State, and are also very extensive strawberry growers.

J. C. Philips, Salisbury, Wicomico county. Small grower of strawbery and blackberry.

William Pritchard, Henderson, Caroline county. Small grower of peach.

B. C. Pullen, Church Hill, Queen Anne county. Small grower of peach.

J. A. Ramsburgh, Frederick county. Grower of general nursery stock; specialties, peach, apple and quince. Has the largest block of quince in the state, and second largest block of apple.

Chas. K. Shank, Smithburgh, Washington county. Small grower of peach, apple and pear.

Wm. M. Stevenson, Ringgold, Washington county. Small grower of peach, quince and small fruits.

E. Stoner, Westminster, Carroll county. Grower of general nursery stock; specialties, apple, peach, pear and ornamentals.

C. T. Sweet, Swanton, Garrett county. Small grower of apples, ornamentals and strawberries.

Hiram G. Tarbutton, Sudlersville, Queen Anne county. Small grower of peach.

C. Thayer, East New Market, Dorchester county. Small grower of strawberry and blackberry.

Richard Vincent, Jr. & Son, Whitemarsh, Baltimore county. Small growers of strawberry and blackberry; general dealer in ornamentals and vegetable plants.

M. B. Waite, Arundel, Anne Arundel county. Grower of general nursery stock. Specialty, peach, pear and apple.

H. J. White, Poolesville, Montgomery county. General grower of nursery stock; specialties, peach, apple, pear and strawberry.

H. B. Witter, Frederick, Frederick county. General grower, specialty, peach, apple and plum.

W. J. Woolen, East New Market, Dorchester county. Small grower peach, apple, and gooseberry.

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THE MARYLAND
AGRICULTURAL EXPERIMENT STATION

BULLETIN No. 58. SEPTEMBER, 1898.

The Hessian Fly in Maryland.

BY WILLIS G. JOHNSON, A. M., ENTOMOLOGIST.

INTRODUCTORY.

That delicate little insect, commonly called the Hessian fly, but known to science as *Cecidomyia destructor* Say, appeared in our wheat fields in such destructive numbers last fall and this spring, we have thought it wise to publish a brief, popular bulletin, giving the general public such information as is available, at the present time, for its suppression and control.

It is usually more or less abundant in certain sections of the state every year, but some seasons its attacks are far more serious than at other times. During the fall of 1896, I saw several fields of wheat in St. Mary's county that were quite badly infested; and in the fall of 1897, I noticed many fields in Western Maryland seriously damaged, some of them almost totally destroyed. In addition to our personal observations, we have collected much valuable information upon this topic from the farmers themselves through a circular of inquiry. These reports represent every section of the state, and indicate that the insect has been unusually abundant this year. As many inquiries have been made regarding its life history and habits, I will give a short account of its importance, origin, distribution, and transformations.

IMPORTANCE.

The Hessian fly is regarded as one of the most destructive of all our injurious insects, especially, from the fact, that it attacks our most important cereal crop. The minimum annual loss to the growers in wheat producing sections of the United States by this pest is estimated at over 40,000,000 bushels; or in other words, about 10 per cent. of the crop. Some seasons, the ravages are much worse than others, and it is not an uncommon thing to find local losses amounting to fully 50 per cent. or more; and sometimes total failure. In Maryland alone, the wheat crop has been short about one-quarter this year and I estimate that one-fourth of this is due to the Hessian fly. In other words the loss to the farmers is about $750,000.00 from this one insect.

DISTRIBUTION.

The Hessian fly is now thoroughly established in the entire wheat-growing belt of the United States and Canada. It is an imported insect and is supposed to have been introduced in straw brought over with the Hessian troops during the war of the Revolution, as it became very injurious on Long Island three years later, that is 1779, in the vicinity of the place where the troops landed. The spread of the insect has been slow, but gradual, reaching the Pacific coast about 1884. In Europe, the wheat belt from Russia eastward has long suffered from its attacks. It appeared in England in 1886, and was observed in new Zealand in 1888, where it has since occasioned much injury. It will thus be seen that it has nearly completed its circuit of the globe.

ITS APPEARANCE IN MARYLAND.

The Hessian fly made its first appearance in Maryland fourteen years after the landing of the Hessian troops in 1776, so far as I can ascertain from available published records. It does not seem to have attracted much attention in this state from 1790 to the year 1817, at which time it was very abundant, and "in parts of Maryland and Virginia was perhaps more destructive than it had ever been before." It appeared more or less abundant in 1820, 1830, 1832, 1836, 1840, and each succeeding year to 1843, when "in the central parts of Maryland the crops in many instances, were rendered totally worthless." The following year, 1846, Fitch says, speaking about this insect in Maryland, "so great ravages have not been committed by the Hessian fly since 1817. On some of the best land wheat has been plowed up, and other portions are so much injured they will not be worth harvesting." For the next twenty years the fly attracted very little attention in Maryland and it was not until 1866 that any serious damage was recorded. There was a period of comparative immunity between 1866 and 1871. From this latter date, the pest was quite conspicuous each season to 1874. The following year, 1875, little damage was done, but in 1876, the insect was more abundant. It next appeared in 1879 and 1880, and again in 1882. From 1882 to 1896 it was more or less abundant in local fields, here and there, but not until 1897 was there a universal complaint regarding its ravages. It has been reported to me from nearly every county in the state.

The Hessian fly is an exceedingly delicate, two-winged insect, very much resembling a gnat or mosquito in general appearance, being only one-tenth of an inch in length. On account of its smallness it is very rarely ever seen by the average wheat grower, and I have thought it wise, therefore, to produce the accompanying illustration giving its various stages. It must be remembered that the male and female represented at *f* and *g*, have been greatly enlarged. An insect natural size, is seen at *e*, upon the leaf depositing its eggs.

DESCRIPTION AND LIFE HISTORY.

The Female:—The body of the female (Fig. 27, *f*.) is quite slender and dark brown. It has a round, somewhat flattened head; the eyes are black, the wings uniformly dull, smoky brown, while the legs are paler than the rest of the body. The abdomen is rather full, with segments distinct. As noted above, the length of the fly is about 2.5 millimeters, or about one-tenth of an inch.

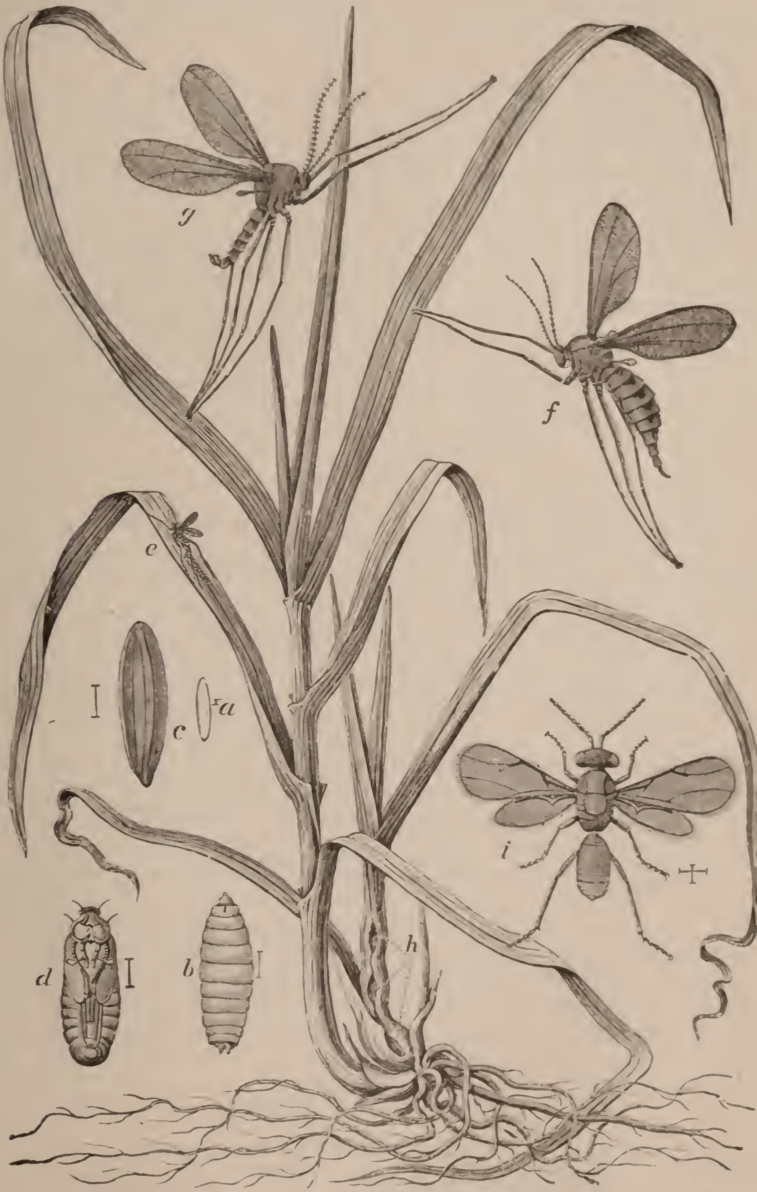

Fig. 27. The Hessian fly and its various stages of development: *a*, an egg much enlarged; *b*, larva or worm enlarged; *c*, flaxseed; *d*, pupa; *e*, adult, natural size, laying eggs; *f*, female, much enlarged; *g*, male, greatly enlarged; *h*, stalk of wheat showing attack; *i*, natural enemy or parasite. (After Packard, Third Rept. Ent. Com.)

The Male:—The male as, shown at *g*, greatly enlarged, is smaller than the female, being easily distinguished by its long, slender abdomen, and its longer and more hairy antennae or feelers.

The Egg:—The egg, as seen at *a*, greatly enlarged, is very minute, being only one-fiftieth of an inch long, cylindrical, pointed at each end, shell shiny and pale red when the young is nearly matured, but lighter at first.

The Larva:—The larva or worm, see *b*, emerges from the egg about four days after it is laid. The time of emerging, however, depending somewhat upon the weather conditions. When mature, the larva is a small, smooth, shining, and oval cylindrical creature, being about fifteen-hundredths of an inch long, with a width of about six-hundredths of an inch.

The Flaxseed:—When the larva becomes full grown it transforms into what is known as the pupae stage. The body turns brown, and finally a bright, chestnut color, becoming somewhat spindle-shape in form, a little larger than the larva, as shown in the illustration at *c*. The hair lines at the sides of the figures indicate the natural size. The form is known as the flaxseed stage on account of its close resemblance to a flaxseed. It is in this condition that the insect remains, transforming to the true pupae, from which the adult finally emerges.

HABITS.

There but two broods of the Hessian fly over a large area of the United States, one appearing in the spring and the other in the fall. There is no question of doubt, however, about there being supplemental broods, both in the spring and fall, particularly in the southern wheat area. In the extreme northern belt, where spring wheat is largely grown, there may be only a single brood.

The flaxseeds that have passed the winter in the fall-wheat produce the winged individuals which appear in the spring during April and May, more abundantly about the middle of the latter month. The eggs are deposited usually on the upper surface of the leaf. With the spring brood however, they are sometimes thrust beneath the leaf sheath on the lower joints. A single female produces from 100 to 150 eggs and they are deposited in irregular rows of from 3 to 5 or more.

Hatching from the eggs the young larvae imbed themselves beneath the sheath and stem causing a more or less distorted plant. The spring brood usually develops in the lower joints near the ground. Under certain conditions the insect may remain dormant in the flaxseed state for a year or more and still bring forth the adult. This is, without doubt, a provision of nature intended to prevent accidental extermination of the species. The migrating brood is the one which appears in the fall: the spring brood does not usually leave the field in which it is developed.

EFFECTS IN WHEAT.

The very dark, green color and the tendency of the wheat to stool, are the first indications of the presence of this insect in the fall. At first glance one would think the wheat was exceptionally healthy. A closer examination, however, shows that the leaves are broader, and that the upright central stems are wanting. Shortly afterward the infested plants turn yellow or brown and die in part or altogether. In badly infested fields, the spring brood attacks the laterals, dwarfing and weakening the plant to such an extent, that it falls readily and cannot be harvested.

NATURAL ENEMIES.

The Hessian fly is attacked by several natural enemies. They are very minute, four-winged creatures and develop within the larvae and pupae. One of them is shown in the illustration at *i*. We have in America, several native species of these parasites, while in Europe there are many more, one of which the Division of Entomology, United States Department of Agriculture has attempted to introduce and colonize in this country. It was successfully imported and was liberated at various places in several states, one distribution having been made near Ceciltown, Cecil county, this state. We cannot expect any direct relief from these parasites as they are effective only in a limited way and under most favorable conditions.

PREVENTION AND REMEDIAL MEASURES.

When a field has once been badly attacked it is next to worthless. Pasturing the early sown wheat in the fall has been recommended and has resulted in much good. The remedies are mainly along the line of farm management, and require much study for various localities.

Late Planting:—After considering the data now in hand, I have concluded to divide the state into three sections, (1) the northern, (2) the central, and (3) the southern, as the time for seeding to avoid the fly varies slightly in each. In the northern section, which includes Garrett, Allegany, Washington, Frederick, Carroll, Harford, Cecil and Baltimore counties, wheat sown between September 28th and October 8th, have produced the best crops and have been less attacked by fly than wheat sown earlier.

The central section, including Montgomery, Howard, upper Prince George and Anne Arundel, Queen Anne and Kent, the most favorable time for planting is from October 1st to 15th.

The southern section includes lower Prince George and Anne Arundel, Charles, St. Mary's, Calvert, Talbot, Dorchester, Caroline, Somerset, Wicomico and Worcester counties, and the period here is from October 5th to 20th.

It must be understood that these dates do not always represent the safety limit, as the weather conditions and seasons have very great bearing on this subject. Elevation is also an important factor. Some years the very latest wheat sown is attacked, but this is not the case very often. The majority of instances favor the dates above given.

Turning Stubble:—Where it is customary to follow wheat on wheat, the stubble should be plowed down just as soon as possible. I do not advise burning over stubble fields.

Rotation of Crops:—The rotation of rops has a great tendency to keep the fly in check, and the value of this system has been many times demonstrated.

Trap or Decoy Crops:—The planting of trap or decoy crops was among the earliest suggestions, and is practiced with gratifying success. Stripes of wheat are sown very early, into which the flies are decoyed where they deposited their eggs. The wheat is then turned deeply under the ground.

Volunteer Wheat:—Volunteer wheat should be destroyed by plowing under or mowing or burning as soon as possible.

It is the purpose of the author to give a more exhaustive account of this insect in his next annual report.

NOTICE.

It is my desire to keep thoroughly in touch with every part of the state, and whenever any insect appears in destructive numbers, I will greatly appreciate it, if specimens are sent immediately to my office for determination. Whenever the interest warrants it, I will make an immediate investigation, advise and assist in the destruction and control of the pest under consideration.

Insects of any kind, including caterpillars or worms, will reach me safely through the mail, if enclosed in a small, pasteboard or wooden box. It is not necessary to perforate the box, as insects do not require much air when sent in this manner. If the farmers of the state would promptly notify me of any local insect outbreak, whenever one occurs, very often many hundreds of dollars could be saved, and a general attack averted. You can have the benefit of our experience by simply asking for it.

SOME IMPORTANT WHEAT DISEASES.

BY CHARLES O. TOWNSEND, PH. D., PLANT PATHOLOGIST.

INTRODUCTORY.

Owing to the fact that the wheat crop harvested in Maryland during the past season was seriously damaged in several sections of the State by various plant diseases, it has been considered advisable to issue a preliminary bulletin, reviewing briefly the nature of these diseases and the means of preventing them. According to the official report for 1897, the State of Maryland produced 12,277,056 bushels of wheat from 639,430 acres. This crop was valued at $11,500,000. The yield for the present season is about one-quarter less than that of last year, which means a loss to the State of nearly $3,000,000. Hence the importance of combating the various diseases and insects, which are in a large measure responsible for this reduction.

The necessity of calling the attention of wheat growers to the disease of this cereal at this time becomes more apparent when it is remembered that several diseases which tend to injure the quality and to reduce the quantity of the grain can be successfully treated only before the seed is sown.

A disease may be produced wholly or in part by unfavorable conditions of climate or of soil While it is impossible to control the former, it should be the first object of the wheat grower to see that his ground is in the best possible condition, not only from the stand point of cultivation, but also in regard to the proper supply of food material. Every unfavorable condition tends not only to reduce the quality and yield of the grain, but it also tends to render the plants more susceptible to other diseases and thereby to injure still further the quality and quantity of the grain produced.

FUNGOUS DISEASES.

Wheat is subject to several fungous diseases, most of which have often been described by other writers, but which evidently have not received serious attention on the part of wheat growers, at least in the application of the preventives. The most common fungous diseases are usually designated as smuts and rusts.

Smuts:—There are several varieties of smuts that often cause the destruction of more or less of the wheat crop. These smuts are commonly known as "Bunts" or Stinking Smut and Loose Smut. Two varieties of the former are often found in wheat fields. Sometimes they are both found in the same field: sometimes only one is present. These species, known as *Tilletia Tritici* and *Tilletia foetens*, are distinguished by the microscopical appearance of the spores. In the former, the outer wall of the spores is covered with a series of ridges, giving the coverings of the spores a net-like appearance, while the latter are covered with a smooth outer wall. It should also be noted that the spores of the latter are more elliptical in shape than the former. The smut spores cling to the grains of wheat, and are therefore sown with the wheat. When the wheat grains germinate the spores germinate also and the fine tubes which are produced by the germination of the spores and which make up the fungus penetrate the tissues of the seedling, and thus the two plants grow. one within the other. By the time the wheat plant has become full grown, and has begun to form its head, the smut plant has grown up through the stem, so that when the grains begin to form, the thread like structures of the fungus push directly into the kernel, where it forms its new spores. These spores increase in size, causing the diseased kernels to become much larger than the healthy ones, thus giving to the whole head a swollen appearance. The diseased heads have also a brown or grayish color, instead of the characteristic yellowish tinge of the normal heads. It is often the case that this disease is not observed in the field, but if close examination is made at the time of ripening of the heads, the diseased grains, if present, may be detected by crushing, when it is found that the grains are made up largely of a brownish powder (the spores) which emit a disagreeable odor. It is evident that all heads filled with the smut are worthless and worse than worthless, since they not only reduce the yield of wheat, but also furnish the spores for the perpetuation of the pest. The loose smut (*Ustilago Tritici*) attacks the young wheat plants in the same manner as do the stinking smuts, the spores in this, as in the preceding case, often being sown with the grain. The fungus also spends its existence within the body of the host plant; its spore formation, however, is not confined to the grains, but appears in all parts of the head, apparently transforming the head into a loose, powdery mass. This disease is readily recognized before the grain is ripe, but as a rule it is not nearly so destructive as the stinking smuts. The spores often ripen and are blown away before the grain is ready to be harvested, so that at harvest time the field may seem to be almost or quite free from loose smut. By looking closely, however, the headless straws may be seen, showing where and to what extent the fungus has done its destructive work.

PREVENTIVE.

Since these disease-producing fungi spend their existence within the host plant, it is evident that the remedy must be preventive rather than curative, since any application which would destroy the life of the fungus would also tend to injure or destroy the life of the host plant. Hence, the simplest method of preventing the disease is to destroy the spores before they begin to germinate. For this purpose several methods have been employed with success, especially with the stinking smuts.

*Hot Water Method:**—It has been found by experiment that it is possible to destroy the vitality of the spores which cling to the wheat grains without destroying the germinating power of the grains themselves. Indeed, the grains which are treated with hot water tend to germinate more readily than do untreated grains, a condition, which in itself tends to prevent the action of the smut. The method of treating wheat with hot water has been given at length by Swingle** and others, and should be carried on as follows: Fill two large kettles with water, and heat the water to 110 degrees F. in one kettle and 132 degrees F. in the other. Place the wheat to be treated in a sack or basket and dip it into the first kettle until the grain is warmed, then plunge it for fifteen minutes into the second kettle. In both cases, the grain should be agitated by lifting and plunging into the kettle, or otherwise, so as to bring the surface of each grain into contact with the hot water. This is facilitated if the sack or basket is only partly filled with grain. Care should be taken that the temperature of the water in the second kettle does not rise above 135 degrees, as that temperature is liable to injure the germinating power of the grain. If the temperatnre of the water rises above 132 degrees, the time of treatment should be reduced, e. g. at 135 degrees the grain should not be immersed for more than five minutes. If the temperature of the water falls below 132 degrees the time for immersion should be increased. In no case should the temperature be allowed to fall below 130 degrees, since the smut spores are liable to resist a lower degree of heat. The best method for retaining the proper temperature of the water is by the addition of hot or cold water as the case requires. As soon as the grain has been treated with hot water, it should be spread on a *clean surface* to dry.

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*Jensen, Ueber die Verhuting des Kornbrandes. 1890.

**Farmers' Bulletin, No. 75, U. S. Dept. of Agr. 1898.

The spores of loose smut seem to be a little more resistant than those of the stinking smut, for which reason a slight modification of the above treatment is recommended as follows: Soak the grain for four hours in cold water and set away in wet sacks for about four hours more. This renders the spores and also the grain less resistant to the action of the hot water, for which reason, the grain should now be submerged but five minutes at 132 degrees. Even this treatment will destroy the germinating power of some of the grains, which makes it necessary to sow about one-half more seed per acre. The grain may be treated according to the above directions at any time before seeding, i. e. several weeks or even months before it is to be sown, providing it is kept in a clean place until ready for use. If the grain is to be sown with a drill, it must be thoroughly dry, but if it is to be sown broadcast, a little dampness will do no harm.

Other Preventives:—Other methods for preventing grain smuts have been discovered from time to time. One form cf treatment which has received considerable attention, and which has been very successful, especially with stinking smuts, consists in soaking the grain for several hours in a solution of copper sulfate. A one-half per cent. solution, in which the grain is soaked for twelve hours seems to be most effectual. Solutions of arsenic, lime, salt, and other substances have been tested with more or less satisfactory results. To these methods may be added the simple process of washing the grain with pure water, which results in removing more or less of the smut spores from the grains. The effect of various methods of applying heat, e. g. dry heat, moist heat, heated air, etc., have been investigated, and have been found to be in a measure successful, although the hot water method is considered on the whole most effectual.

RUSTS

Rust often makes its appearance on the leaves of wheat plants, and may be recognized by the yellowish streaks and patches which it forms. The spores of the fungus are carried by the wind and lodged on the leaves and straws, where they germinate and send their thread-like structures into the tissue of the wheat plants, from which they draw nourishment for their own growth and development. The germination of these spores is greatly facilitated by the presence of moisture and heat, hence we find the rusts worse during moist, hot seasons. The fungus plants produced by the germination of rust spores do not attack the grain directly, but they draw so much nourishment from the straw and foliage that the grains are unable to develop, and therefore, present a shrivelled appearance when ripe. The yellowish streaks and patches are masses of spores which may be blown on to adjacent wheat plants, and thus the disease may spread from plant to plant until whole fields are affected. As the season advances, the yellowish streaks and patches give place to a darker color, due to the formation of other spores, known as winter spores. These differ from the former, in having thicker, darker walls, in being composed of two parts (cells), and in their ability to retain their vitality through the winter

Remedy:—Since the spores that produce this disease are not sown with the grain, it is useless to treat the seed itself for the disease. Many attempts to spray the fields of grain with different fungicides for the prevention of rust have been made but so far the efforts in this direction have given very little satisfaction. In as much as this disease usually appears rather late in the season, it has been suggested that those varieties be grown that ripen early. This will prevent in a large measure the destructive action of rust. It should also be borne in mind that certain varieties, e. g. the red wheats, are more resistant to rust than others, although it appears that no variety is rust proof. Also the varieties with thicker or tougher skins are less liable to be infected with rust. Since it is evident that the winter spores remain on the stubble during the winter, a crop that has been infested with rust should not be followed immediately by another grain crop. Usually, an interval of one year is sufficient to destroy the spores. In the rotation of crops it should be remembered that rusts will live upon grasses as well as upon wheat. If circumstances are such that it is necessary that a grain crop should follow a grain crop which was infested with rust, the stubble should be burned, in order to destroy the rust spores.

SEPTORIA.

During the past season the wheat crop in certain sections of our State has been greatly injured by another fungus, a species of Septoria (probably *Septoria glumarium*). It does not appear that this fungus has heretofore produced any damage to wheat in this State, although it has been seen in Europe and possibly in some parts of our own country. I have not been able, however, to find any account of its appearance in America. It is seen soon after the heads are formed, and attacks the straw, leaves and glumes, but does not attack the grain itself. It spreads rapidly over the individual plants, and from plant to plant, and draws so much nourishment from its host just at the time when the heads are filling, that the kernels are very much shrivelled. It often appears most distinctly upon the heads, giving them a dirty appearance. Upon close examination, the infested parts are seen to be covered with numerous, small, black dots which are masses of spores in little cavities (Pycnidia.) It is impossible to estimate at this time, the amount of damage done by this fungus during the past season, but in a single instance, one field that gave every indication of producing from 30 to 35 bushels per acre of A No. 1 wheat was so injured in a few days by this pest that the yield was reduced to 15 bushels per acre of inferior grain. In other sections the degree of injury has been more or less marked. It has been impossible to investigate the disease fully during the past season. If it appears next year, it will receive special attention, the results of which will be published in another bulletin.

It is probable that the suggestions given for the prevention of rusts will in a measure prevent the destructive action of this disease.

NOTICE.

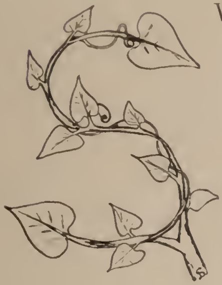
In case any fungous disease makes its appearance in this state, I should be very glad to have specimens of the diseased parts of the plant sent to my address. This will enable me to know what disease we have to contend with, and where they are located. Such specimens may be enclosed in an envelop or box and sent by mail. If a remedy or prevention is known I shall take pleasure in sending directions for treating the disease, and if a remedy or preventive is not known it is important that the disease be brought to my attention in order that a means of combatting it may be found. Whenever the case demands it, I shall be glad to make a personal inspection of the diseased plants in the field or orchard.

THE MARYLAND
AGRICULTURAL EXPERIMENT STATION

BULLETIN No. 59. JANUARY, 1899.

SWEET POTATO INSECTS.

By E. Dwight Sanderson, B. S. A., Assistant Entomologist.



SWEET POTATOES are one of the most important crops of the Southern counties of Maryland on the Eastern Shore of the Chesapeake Bay, as well as of Anne Arundel county on the Western. Out of a total yield of 44,000,000 bushels from eighteen states in 1890, the census quoted Maryland with only 408,000 bushels. Recent crop reports, however, estimate a yield of 2,000,000 bushels for the Maryland-Virginia peninsula. Baltimore, doubtless, stands next to New York as a sweet potato market, and about one-half the Maryland crop is shipped there; however, through the opening up of the other markets, this industry has received somewhat of a stimulus in the last few years.

The sweet potato market is one which pays well for the early crop, but is always glutted at the height of the season. This year it opened at $5.00 to $6.00 per barrel, but when the whole crop commenced to come in during October, the price sank to as low as 25 to 35 cents.

Injurious insects (Flea Beetles, Tortoise Beetles and Cut Worms), which so damage the newly set plants as to seriously stunt their growth, and thus prevent early maturity of the tubers, are thus one of the most important factors opposing profitable sweet potato culture. And not only do they prevent an early crop, but the damage done to the young vines seriously curtails the late crops.

A plot of sweet potatoes for testing the varieties, planted by Prof. J. S. Robinson at this Station, was observed to be more or less badly injured by Flea Beetles and Tortoise Beetles soon after being set out. One row of Early Rivers was so badly eaten that it was taken up and planted in Big Stem. Notes taken on June 1st, 1898 were as follows:

Big Stem:—Older leaves are badly eaten, but are tough, and plants are recovering from injury, sending out new leaves.

Jersey Red:—Plants seem to have been attacked when very young and have been badly stunted. Some are entirely stripped of foliage.

Paragon:—Not so badly injured as Jersey Red. Are making good growth now that beetles have gone, before the eggs hatch.

Early Rivers:—Plants very badly eaten. Large part of rows killed by beetles.

After these varieties were planted, there ensued a most prolonged drought until about the 12th of August, which only tended to render more apparent the injuries of the beetles. From May 19th to August 12th there was only about 2½ inches of rain fall, the most of this being a half-hour shower of 1¼ inches on July 16th. Subsequent to August 12th, there was an equally bad drought until Oct. 18th, during which time there was scarcely over one-half of an inch precipitation. The final yield from these rows is most interesting as corresponding exactly with the out'ook indicated from the above notes, and has been kindly furnished me by Prof. Robinson. Upon one of these plots barn yard manure was used and on the other a commercial fertilizer

	Barn-Yard Manure.				**Commercial Fertilizer.**			
VARIETY.	GRADE.			Per Acre bus.	GRADE.			Per Acre bus.
	1st's lbs.	2d's lbs	Culls lbs.		1st's lbs.	2d's lbs.	Culls lbs.	
Big Stem	244	37	25	253	351	43	23	346
Paragon	114	31	52	164	147	37	27	175
Jersey Red	44	19	26	73	79	25	20	102
Early Rivers	9	6	15	25				

In considering the different injurious insects of this plant, I have grouped them according to the different parts of the plant attacked by them so that they may be more readily recognized by the reader, from the nature of the injury.

Feeding Upon The Tubers.

The Sweet Potato Root-Borer or Weevil.

(*Cylas formicarius*—Olivier.)

Though never reported from Maryland, this insect has sometimes nearly destroyed the crops of certain localities in Florida, Louisiana and Texas, often preventing the growth of the crop for a year or two, and Maryland growers should be on their guard against it in securing stock from those districts.

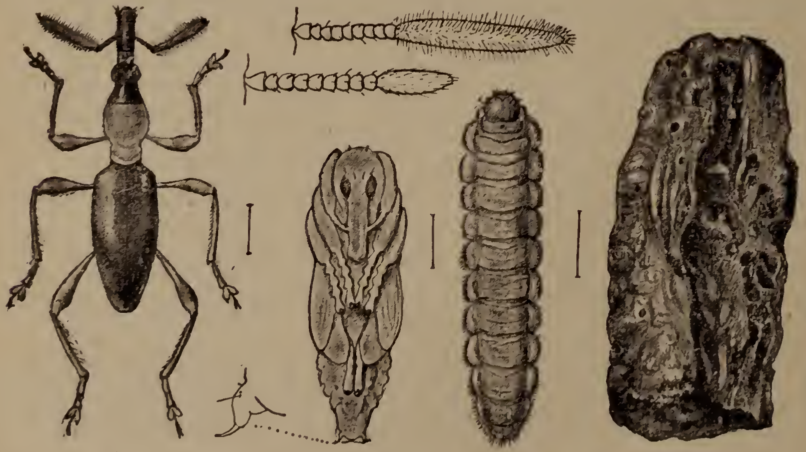


Figure 28.—The sweet-potato root borer (*Cylas formicarius*). Extreme left hand figure adult beetle, with enlarged antennæ at right. Figure at left center, pupa; at right centre, larva; at extreme right, portion of sweet-potato tuber channeled by borer. All figures except the last considerably enlarged; natural sizes indicated by hair lines. After Farmer's Bulletin, No. 26, U. S. Dept. Agr.

It is a cosmopolitan insect, being reported by Dr. J. H. Leconte from Cochin, China, India, Madagascar, Australia and Cuba, and recently by Prof. C. H. T. Townsend from Jamaica, where it was imported from Cuba. It was doubtless from Cuba that it was also imported into Louisiana, where it was first noticed in the vicinity of New Orleans in 1875 and has since spread North along the Mississippi River*

In 1879 it was reported from Florida and at that time was studied by Prof. J. H. Comstock, then U. S. Entomologist.*

From 1890 to 1892 it did very serious damage in Louisiana and Texas, but strangely, has not been reported as injurious elsewhere.

The beetle is a rather slender insect, and has received its specific name "formicarius" from its close resemblance to an ant. It is about one-fourth of an inch long, of a bluish black color, and with a reddish brown prothorax.

In the sub-tropical climate of these states, the insect seems to breed during the whole year, Prof. Comstock having observed three generations, and specimens then doing injury have been recorded at all seasons of the year.

The yellowish-white, oval eggs are deposited in small cavities eaten out by the mother beetle, either at the base of the vine or at the stem end of the tuberous root, and Prof. Morgan, (l. c.) records their being placed in the tubers.

The latter point is important, as showing that the insect might continue to breed after the potatoes had been dug and stored, and also the ease by which it might spread.

The small white grubs commence to burrow in the vine as soon as hatched and then descend to the tubers, which, in the course of the season, and by the aid of the beetles, they thoroughly riddle. The full grown larva is about the length of the beetle, the joints of the segments are strongly constricted and the legs are absent, being represented by mere tubercles.

The grub now forms a small cavity at the end of its burrow and transforms to the pupa. In this stage it remains from eight to fourteen days, when the adult beetle emerges and spends about six days in depositing eggs for another brood. Thus the whole life cycle requires from 35 to 39 days.

From the nature of the injury it is apparent that the only method of combatting this pest it to remove all small or badly infested tubers and feed them to hogs, and burn all the vines.

In receiving tubers from infested states, it would always be wise for more northern growers to fumigate them before planting. Carbon bisulphide has been successfully used for this and hydrocyanic acid gas, as used for fumigating nursery stock, would be entirely safe, if not used in too large a dose.

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*See Bul. No. 28 La. State Expt. Sta. (Baton Rouge), Report of the Entomologist, H. A. Morgan, P. 999 (1893).

*See Report U. S. Sec. Agr. 1879, P. 249.

Cutting the Stems.

Cutworms.

These inveterate enemies of the trucker, the Cutworms, do not usually fail to devote due attention to the young sweet potato plants when they are first set out and frequently their injuries are such as to make necessary considerable resetting. The rigor of their attack is doubtless due to the fact that sweet potatoes are usually planted on light soil which has no other covering than weeds and grass during winter and is cultivated for some little time before the plants are set out, thus thoroughly starving the cut worms and putting them in excellent condition for a hearty meal.

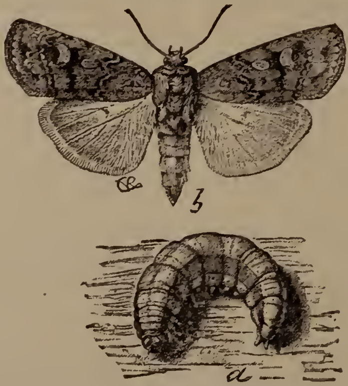

Figure 29.—The Dark-Sided Cutworm (*Agrotis messoria* Harr). a, larva; b, moth. (After Riley.)

Though many species injure the young plants by cutting the stems at the surface of the ground, the dark-sided cutworm (*Agrotis messoria* Harr.) has most often been recorded* as specially preferring them and an account of it will be more or less typical of all the nearly related species. Grass lands is the usual habitation of cut worms and here the eggs are deposited in late summer and hatch in a few days. The young worms eat rather sparingly, and are only partially developed by the first frosts, when they curl up under such shelter as is securable and hibernate during the winter. With the appearance of vegetation in the spring they revive and commence to eat voraciously. Thus, as already shown, if their only food plants are turned under and the ground cultivated before the potato plants are set. such a precedure only sharpens their already intense appetite. The larvae become full grown the latter part of May and enter the pupal stage, from which the adult moths emerge in July and August. Fortunately, there is but one brood of this species, but of many there are two.

Remedies.

If practicable, deep fall plowing will turn under large numbers of the young worms and thus destroy them. Otherwise, keep the land thoroughly cultivated in the spring, and about three or four days before setting out the plants, scatter over the field bunches of grass or clover from a plot which has been thoroughly sprayed before cutting with a mixture of one pound of Paris green to one hundred gallons of water. By placing these poisoned baits every fifteen to twenty feet apart, the cutworms will be lured out of the soil to a certain death and all will soon be found dead, about an inch below the surface.

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*Report N. J. Agr. Expt. 1892, P. 469, Dr. J. B. Smith.

If appearing late in the season, a mash composed of fifty pounds of wheat bran, one pound of Paris green and about two quarts of cheap molasses with just enough water to moisten it, will be found more convenient. A tablespoonful placed on the ground near the plants every 10 or 12 feet will be sufficient.

Eating the Leaves.

The Sweet Potato Flea Beetle.

(*Chaetocnema confinis* Cr.*)

As soon as the plants are set out, the leaves are often attacked by a small, brownish-black flea beetle. Small channels are eaten out in both surfaces of the leaf in a very characteristic manner, and often almost the whole surface is thus seared, but the leaf is never punctured. As a result, many of the leaves of the seedling are killed outright, turn brown, and decay, while a new growth puts out from below, thus often checking the growth of the young plant to a considerable extent, though never doing noticeable damage later in the season. Their attacks have been found to be worst on low land and that previously in sweet potatoes, and their work is always first noticed in that portion of a field nearest a fence, row or woodland where they have hibernated.

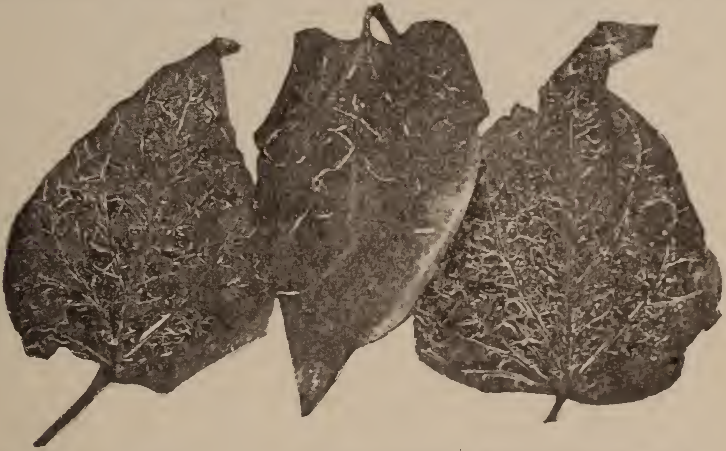

Figure 30.—Work of the sweet potato Flea Beetle (*Chaetocnema confinis Cr.*) (After Smith.)

Dr. J. B. Smith, of the New Jersey Agr. Exp. Station, has made many careful observations upon the work and habits of this insect (See Rept. N. J. Agr. Exp. Sta. 1892, Page 472.), but so far, has been unable to find any other stage than the beetle, and such has been the experience of the writer, even after the most diligent search. Evidently, like many of the flea beetles, the eggs are placed upon the roots of one of our common weeds, upon which the larvae feed.

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*(Syn.—Chaetocnema confinis Cr. C. flavicornis Lec.)

May 21st, 1892, Dr. Smith found the sexes copulating; on May 30th, the beetles were most numerous, and by June 13th, had begun to disappear. By July 1st, the beetles were entirely gone.*

On the vines at the Experiment Station the beetles were most numerous this year during the first week in June and were not to be found after July 1st.

Remedies.

Probably the easiest method of treating this pest, and which will also be of service in fighting the beetles next described, will be to dip the plants in a solution of arsenate of lead while setting them. This is rather a new insecticide, but one coming rapidly into favor, being both safe and cheap, costing somewhat less than the other arsenates.

Eleven ounces of acetate of lead and four ounces of arsenate of soda are dissolved in one hundred gallons of water. The substances combine and from a white precipitate which is the arsenate of lead and should be kept well stirred. Two quarts of glucose or molasses renders the mixtures much more adhesive. Smaller amounts may be used in like proportions or a strong stock solution made up and then diluted as needed for use. Arsenate of soda costs about 8 cents per pound and acetate of lead 14 cents.

A spray of Bordeaux mixture, if applied immediately after the plants are set out, will prove objectionable to the beetles and lessen their attack.

Tortoise Beetles.

Of all the insects affecting the sweet potato, the brilliant, little golden beetles belonging to the family Cassidae, which from the broad expansion of their thorax and wing covers, are fancied to resemble a tortoise, are the most common and are peculiar to it. They are beautiful little insects with a peculiar power of changing color, some of the species even appearing like drops of molten gold.

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*Collectors at Philadelphia have taken the beetles in July and August, and Mr. Wenzel has ascertained that they hibernate during winter.

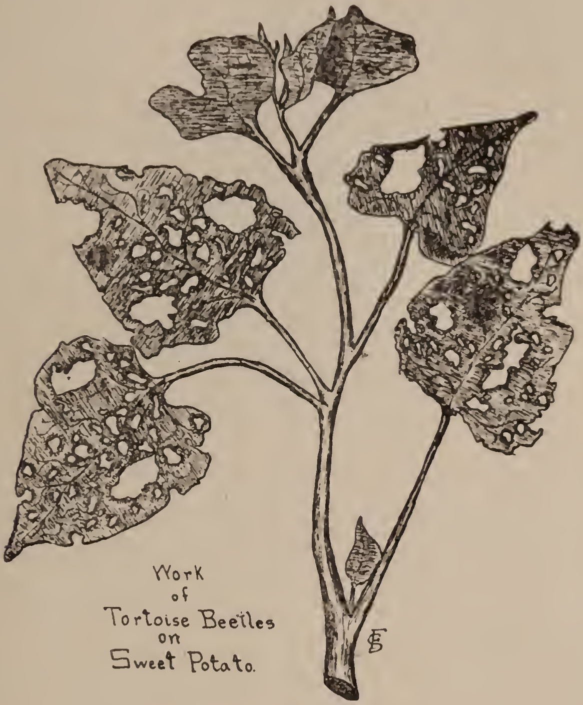

Figure 31.—Original (Drawn by Franklin Sherman, Jr)

The larvae of these beetles are, however, almost as disagreeable as the adults are attractive, but are nevertheless veryinteresting creatures. Each of them is provided with a tail-like fork at the end of the body which is almost as long as the body, and in those species in which it is depressed, entirely conceals the insect. Upon this fork is heaped the excrement and cast skins of the larvae, and when covered by this "umbrella," as it is often called, it is with great difficulty that the larvae is distinguished from a bit of mud or a bird dropping.

The manner in which this fork increases with the size of the insect is rather interesting. At each molt the faeci-fork of the last stage is held upon the faeci-fork of the new stage, and in this way the faeci-forks of all stages are telescoped, the one inside the other, as shown in figure 32, and the stage of the larvae may thus be readily determined. From the likeness of the burden on this fork to a pack, the larvae are often designated as "peddlers."

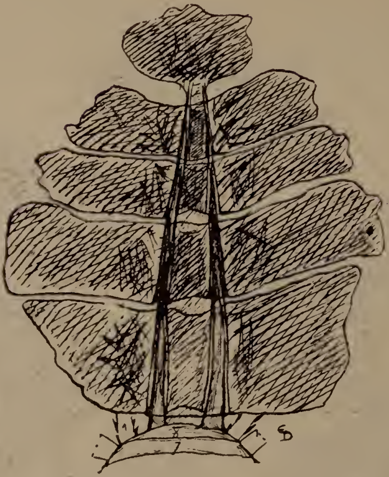

Figure 32.—Faeci-fork of larva of *Coptocycla bicolor F.*—(Original.)

The tortoise beetles affecting the sweet potato are distributed among three genera, but are sufficiently alike in their general habits and life history to be classed together in that respect. The beetles hibernate over winter, and in the spring before the potato plants are set, they feed on their native food plant, the morning glory.

As soon as the plants are set out, the beetles commence to eat large round holes in the leaves, and so riddle them that it is often necessary to replant. The worst damage, however, is done to the set, and on both the leaves and stem of it the eggs are laid. Very rarely have I found the new shoots eaten or eggs upon them, and this fact renders it much easier to spray for them, as at this time the plant has not yet commenced to run, and the older portion is still upright.

The larvae hatch during the first two weeks in June, and require slightly over two weeks to become full grown, there being five molts. Though the larvae also do considerable damage by eating the leaves of the plant, it is not nearly as serious as that done by the beetles and rarely becomes noticeable.

In order to more firmly bind the excrement and cast skins to the fork, the larvae fasten them together by a fine network of silken threads, which are then attached to the spines on the sides of the body. Just how this is done, I have not been able to determine, but am well satisfied that it is a fluid excretion from the vent, which hardens into fine threads upon exposure to the air. When fully grown, the larva fastens itself to a leaf by means of this excretion, its skin splits open along the back, and from it comes the pupa, which is held to the leaf by its caudal fork, being securely encased in the faeci-fork of the larval skin. About a week later the adult beetle emerges, eats for a few days and then disappears from the sweet potato patch until the following spring, and again feeding more or less on morning glory.

CASSIDAE.

Considerable variation exists in the life history of the various species at different latitudes, as may be seen from the following tables:

	Eggs Hatched.	Pupated.	Beetle Emerged
Ithaca, N. Y., bred by writer.	Colected larvae July 19th.	July 31st.	Aug. 8-9.
New Jersey by Dr J. B. Smith.	June and July.	July 10th.	July 15-August.
College Park, Md., bred by the writer.	June 11th.	June 29th.	July5-9
Fort Collins, Colo., by C. F. Baker.	Larvae on June 2nd.	July 9th.	July 19th.

Coptocycla bicolor Fab.

College Park, Md., 1898. Hatched June 11th, Pupated June 29th, emerged July 5th.-9th.

Ithaca, N. Y., 1897. Larvae collected June 19th, Pupated July 30th, Emerged Aug. 8th-9th.

Coptocycla Signifera Fab.

College Park, Md., 1898. Hatched June 11th, Pupated June 27th, Emerged July 2nd-7th.

Ithaca, N. Y., 1897. Larvae July 19th, Pupated July 31st-August 5th, Emerged August 9th-14th.

Chelymorpha argus Licht.

College Park, Md., 1898. Hatched June 15th-19th, Pupated July 3rd, Emerged July 3rd-19th.

Ithaca, N. Y., from Newark, N. J., 1897. Larvae nearly grown July 18th, Pupated July 20th, Emerged July 29th.

Ithaca, N. Y., 1885. Eggs collected July 15th.

Cassida nigripes Oliv.

College Park, Md., 1898. Hatched June 15th, Pupated June 29th, Emerged July 12th.

Fort Collins, Colo. Larvae on July 2nd, Pupated July 9th, Emerged July 19th.

Cassida bivittata Say.

College Park, Md., 1898. Larvae June 29th, Beetles emerged July 5th-9th.

The Two-Striped Sweet Potato Beetle.

(*Cassida bivittata* Say.*)

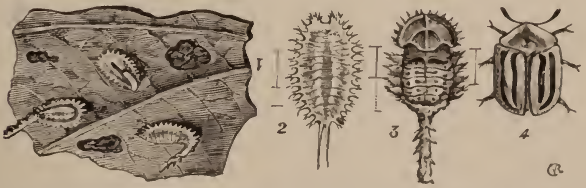

Figure 33.—The Two-Striped Sweet Potato Beetle (*Cassida bivittata* Say). 1, larvae on leaf; 2, larva; 3, pupa; 4, beetle. (After Riley).

Usually this species is recorded as the most common of the Tortoise beetles, attacking sweet potatoes, but this year it has been the least common upon the vines of the Experiment Station. The species differs from the others in several important characteristics, notably in that the larva does not use its faeci-fork for carrying excrement, but merely covers it with cast skins and holds it at an angle from the body, instead of close down upon the back. Dr. Riley states that the species is confined to the sweet potato plant, but we have found it feeding upon morning glory vines early in the season, as do the other species. The larva is yellowish-white, with a longitudinal band along the back, each side of which is a much lighter hand. The beetle is palr yellow, striped with black, as shown in figures 33, 34.

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*(Syn.—Cassida bivattata Say., C. vittula Boheman, C. striolata Boheman.

The Black-Legged Tortoise Beetle.

(*Cassida nigripes* Oliv.*)

The larvae of this species do far more injury to the plants than those of any other species (those of *Chelymorpha argus* Licht., are much more voracious, but are comparatively uncommon on sweet potato,) both on account of their larger size and the manner of their attack. The eggs of other species of the genera Cassida and Coptocycla are laid singly, and thus only one or two larvae will be found on a plant, or if more occur, they are scattered, but the eggs of this species are laid upon the stems in rows of from three to a dozen, and upon hatching, the larvae make a combined attack upon some one portion of the plant, thus making the injury much more noticeable.

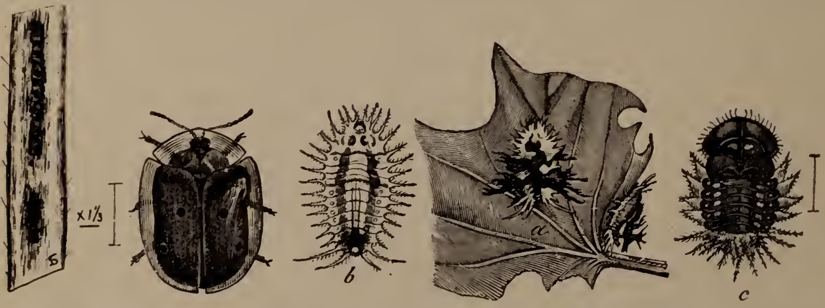

Figure 34.—The Black-legged Tortoise Beetle. (*Cassida nigripes Olir.*) a, b, larvae c, pupa, d, beetle, (After Riley.) e, eggs.

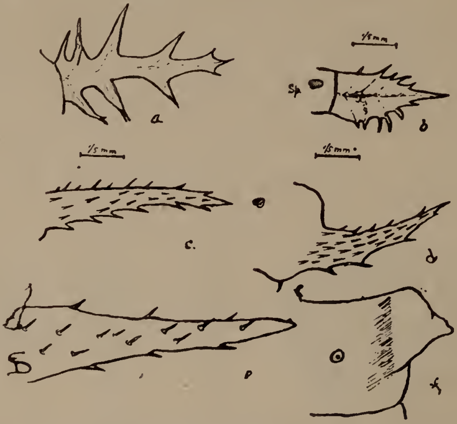

Figure 35,—Lateral tubercles of Cassida larvae and pupae. (*Coptocycla signifera Herbst* a, larva, b, pupa. *Chelymorpha argus Licht*, c, larvae, d, pupa. *Physonota unipunctata*, e, larva, f, pupa. Original.

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*(Syn.—Cassida nigripes Oliv., C. novemmaculata Mann., Var C. nigripes atripes Lec., C. ingripes ellipsis Lec.)

The larvae are a bright, straw yellow, with two crescent-shaped, black marks just back of the head and with the spines at the side of the body tipped with black. They are considerably larger than the other species of Cassida and Coptocycla, and can be recognized at a glance by the characteristic manner in which the dung is spread upon the faeci-fork.

The beetle very closely resembles *Coptocycla bicolor* Fab., but is not so brilliant, larger, has black legs, and the three black spots on each wing cover are larger and more conspicuous.

Cassida Nigripes and the species just mentioned were the most common noticed here this season, and the larvae of the former were the latest in their transformation.

The Golden Tortoise Beetle.

(*Coptocycla bicolor* Fab.)*

This is also a very common species, and may be found upon morning glory vines throughout the summer. The eggs of this species are quite different from other species of Coptocycla and Cassida in having three spiny prongs projecting from one margin. The larvae is easily distinguished by being entirely concealed by the heavy load of excrement which when the faeci-fork is raised and the light color then extends over the less tri-lobed in outline.

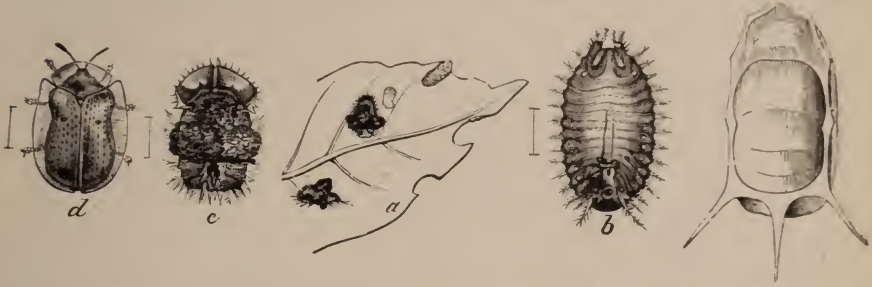

Figure 36.—The Golden Tortoise Beetle (*Coptocycla bicolor Fab.* egg at left, enlarged: a b, larvae; c, pupa: d, beetle. (After Riley.)

Though usually of a dark, brown color with a pale shade upon the back, like the beetle, this larva possesses the power of changing color entire dorsal portion. The pupa with the loaded fork still held close to the back, is hardly distinguished from the larvae at first glance, but when the faeci-fork is raised and the light color then extends over the the fork is removed it may be distinguished from other allied pupae by the three dark stripes on the prothorax and similar dark markings over the abdomen.

The beetles when first emerged, are of a dull, orange color, with three prominent black dots upon each wing cover, but a little later they change to a metallic gold, shining like the most brilliant tinsel, and the black spots are scarcely noticeable. All of the Tortoise beetles, and this in particular, have the habit of dropping to the ground and feigning death as soon as disturbed.

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*(Syn.—Coptocycla bicolor Fabricius, Cassida bistripunctata Herbst., C. aurichalcia Fab., C. aurisplendens Mann.)

The Mottled Tortoise Beetle.

(*Coptocycla signifera* Herbst.)*

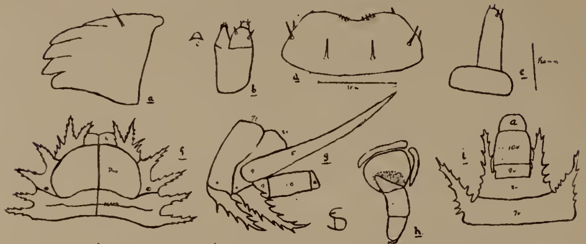

Figure 37.—Larva of *Coptocycla bicolor Fab.* a, mandible, b, maxilla, c, labial palpus d, labrum; e, antenna; f, pro- and mesa--thorax; g, lateral aspect of caudal segments; h, leg, i, ventral aspect of caudal segments.—Original.

This beetle is strikingly different from the other species in being black, marked with six irregular, golden spots, and with a band of black extending across the shoulders to the edge of the transparent margin of the wing covers.

The larva is of a pale straw yellow color during the first four stages, and then carries the excrement upon its faeci-fork in a peculiar branching arrangement much like *Cassida Nigripes* Oliv., but after the last molt the color changes to a pea green, which renders the larva very difficult to recognize upon a green leaf when all excrement is removed from the faeci-fork. Inasmuch as the larva does not feed, and remains almost entirely motionless during the last or fifth stage, this protective covering is a very interesting device or circumstance, which ever way we choose to regard it. The pupa is also of a bright green, marked only by a black ring around each of the first pair of abdominal spiracles.

The Argus Tortoise Beetle.

(*Chelymorpha argus* Licht.)*

The largest of the Tortoise beetles attacking the sweet potato is *Chelymorpha argus* Licht. The common food plants of this insect are milk weeds, but it is also found injurious to raspberry and horse radish, and E. A. Schwarz informs me that a species of Convolvulus is also the original food plant of this species. The beetles vary in size and marking, even from one lot of eggs they are as variable as from different broods.

Thus from eggs which hatched June 19th, 1898 and pupated July 3rd 1898, on July 9th three beetles emerged which were ⅜ of an inch long with a transverse row of four black dots on the prothorax, and the merest trace of two in the caudal angle of the prothorax, the general color being dark yellow. On July 13th, three more beetles of this brood emerged, which were only 9-32 of an inch long, had the four black spots on the prothorax, but also behind them in the caudal angle of the prothorax, two much larger and more prominent black marks, as well as being of a much lighter color. A similar and more striking dimorphism is found in Physonota unipunctata Say., which was formerly the cause of much confusion.

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*(Syn.—Cassida signifera Herbst. C. marylandica Herbst., C. aurata Melsheimer Catalog. 1806, C. guttata Oliv., C. lucidula Boh.. C trabeata Boh.)

*(Syn.—Chelymorpha argus Licht. The synonomy of this species seems to be rather obscure. Gemminger and Herrold give C. cribraria Oliv, as a synonym, though described by him from Guyane. C. cribraria Fabricius seems to have been from "Brasilla." C 17--punctata Say is a synonym.)

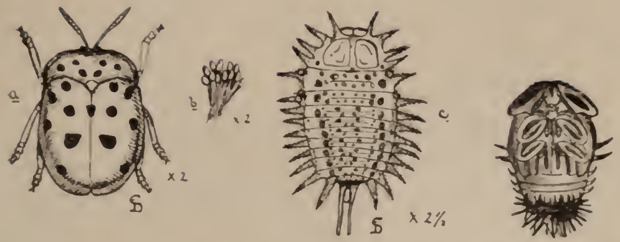

Figure 38.—The Argus Tortoise Beetle (*Chelymorpha argus Licht.*) a, beetle; b, eggs; c, larva.—Original. Pupa, (after Riley) at right.

When fully hardened, the beetle is usually of a brick red color, with six black dots on the prothorax and six on each wing cover, and almost entirely lacking the expansion of the margins of the wing covers and prothorax found in Cassida and Coptocycla.

The eggs are laid in a peculiar manner, being placed in a bunch, each supported by a long stalk or pedicel (Fig. 38, b). Thus when the larvae hatch, they huddle together on the leaves, and very rapidly defoliate a plant. When full grown, the larvae are about one-half of an inch long with the faeci-fork half as long again. They are slightly convex above and stand with the caudal segments elevated: are of a dirty, yellowish color, marked with numerous, dark brown tubercles and prominent lateral spines, as shown in Fig. 38, c. As a rule the faeci-fork is held slanting back from the body and rarely vertical or over it.

The pupa is of a yellowish color, marked with dark brown, which becomes almost black. The ground color of the pupa is almost concealed by a bluish bloom or waxy excretion resembling a mold.

Fortunately, this species is not so common as the others previously mentioned, upon sweet potato, but is often quite injurious to raspberry and horse radish.

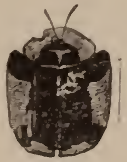

Figure 39.—*Coptocycla clavata Fab.*—After Riley.

In addition to these more common species, are *Coptocycla clavata* Fab., of which the larva is unknown, and which also feeds on the foliage of the Irish potato, and *Cassida nebulosa* Linn. which has recently been found in Lower California, and which has long been known as one of the most injurious of European Cassidae.

Remedies.

From the similarity of their habits and life history, all of these species are readily treated at the same time. Inasmuch as the beetles do the most injury as soon as the plants are set, a dipping of the plants in a solution of the arsenate of lead, as advised for the flea beetles, is doubtless the easiest and most effective means for their destruction. Otherwise, a spray of Paris green should be used as soon as the plants have been set, at the rate of one-quarter pound of the poison, and one-quarter pound of lime to 40 gallons of water. This may best be applied by means of a knapsack sprayer, and the use of an under spray nozzle, so that the under sides of the leaves may be thoroughly sprayed. In either case the object should be to have the plant so coated with poison that the first meal of the beetles will mean their death, thus killing them before they can do serious injury or lay their eggs.

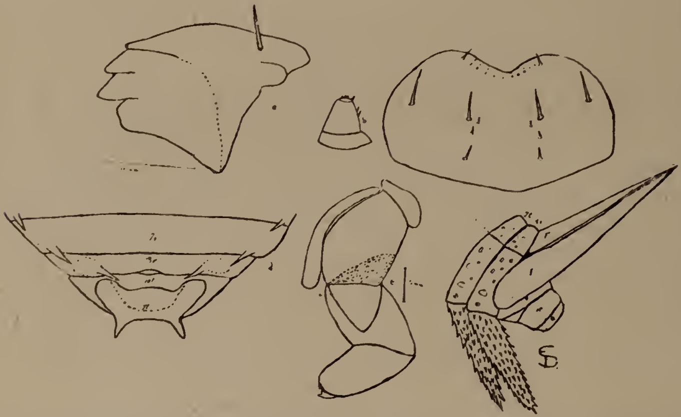

Figure 40.—*Chelymoroha argus Licht* larva. a, mandible; b, antenna; c, labrum; d, ventral aspect of candal segments of pupa; e, leg; f, lateral aspect, candal segments of larva.—Original.

Sawflies.

(*Schizocerus ebenus* Norton.)

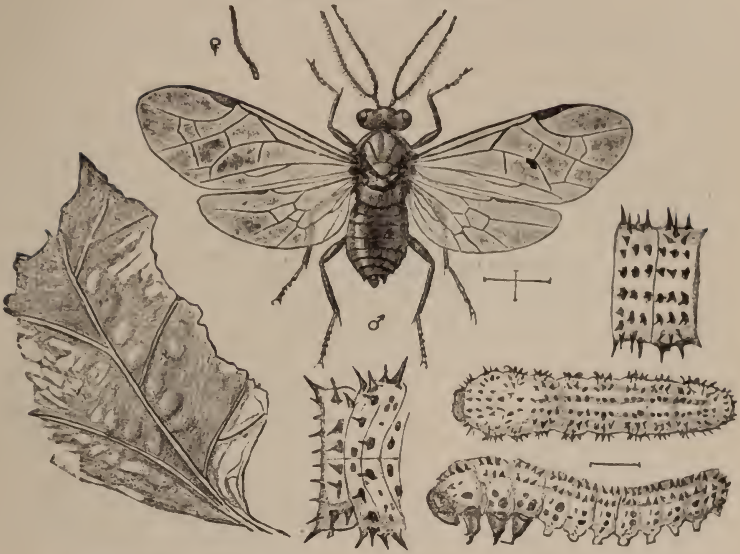

Figure 41.—*Schizocerus ebenus Norton.* Adult Saw-fly above, larvae at lower right (After Riley.)

In 1886, Dr. C. V. Riley, then U. S. Entomologist, described (Insect Life, Vol. 1, p. 43), the injuries and various stages of a sawfly, the larvae of which had practically ruined a crop of sweet potatoes at Ocean Springs, Mississippi. The pest was somewhat injurious for the next two years, but since then, has not been noticed as especially injurious, though the adult insects have been noticed in sweet potato and morning glory

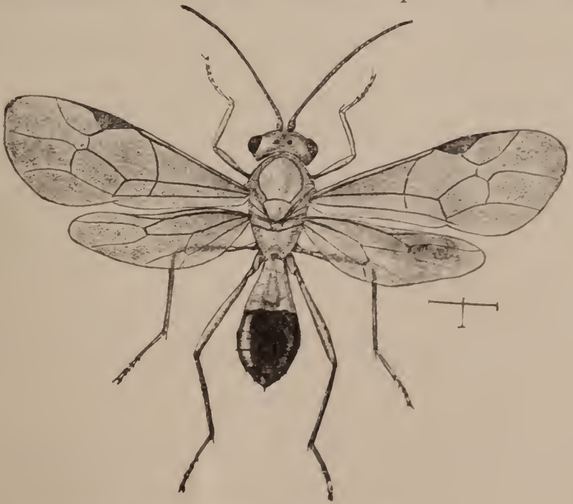

Figure 42.—*Enbadizon schizoceri*, enlarged (After Riley.)

vines in Nebraska. Doubtless, this may be largely due to a little hymenopterous parasite, which Dr. Riley bred from one of the specimens sent him (Fig. 42), and also a small parasitic Tachinid fly. The maggots of these flies live internally upon the juices and tissues of the sawfly larva, and thus probably keep their numbers so largely reduced that their injuries are not ordinarily noticed.

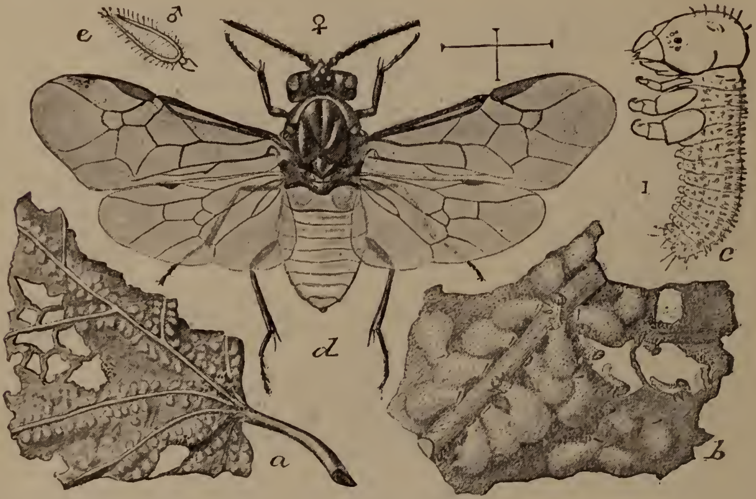

Figure 43.—*Schizocerus privatus Norton.*—After Marlatt.

(*Schizocerus privatus* Norton.)

The larvae of another insect of the same genus was recorded by Mr. C. L. Marlatt, in 1891, (Insect Life, Vol. 5, p. 924,) as being reported as seriously injurying the crop of Mr. C. W. Stockley, Keller, Accomac county, Virginia. I have been unable to learn of any depredations by this insect in Maryland. It seems entirely probable, that, being prevented by further spread southward by the channel of the Chesapeake Bay, it should cross the line and spread into Worcester and Somerset counties, Maryland.

Concerning the work of these larvae, Mr. Stockley then wrote: "Last year, (1890,) was the first time they made their appearance in my potato patch. They came the first of July and deposited their eggs on the leaves; when the eggs hatched, these worms would eat the leaves to a comb. This continued for about four weeks. The potatoes, wherever the fly was, did not make any yield at all. This year the fly made its appearance at the same time they did last year."

Mr. Marlatt found that this species also had a small tachinid fly parasitic upon it.

Adult flies are recorded from Michigan and Nebraska, and were originally described from New Orleans, La.

Remedies.

A spray of Paris green, used as devised for the Tortoise beetles, will be found effective for destroying these worms and should be applied as soon as their injury is noticed, preferably when just hatching from the eggs.

The Sweet Potato Plume Moth.

(*Pterophorus monodactylus* Linn.*)

While examining the vines of the Experiment Station on June 15, I found several small, green worms eating the foliage, and subsequently almost every plant brought into the laboratory was found to have from one to three of them upon it. At that time most of the larvae were half grown, though many were but newly hatched, and one was found already pupated. When full grown the larvae are about one-half an inch long, of a bright green color, with a darker stripe along the center of the back, and thickly studded over the entire body with prominent tubercles, from each of which project a number of stiff, bristly hairs. The prolegs are prominent and have a peculiar, elongated development.*

The larva pupates upon the under sides of the leaves, where the pupa remains suspended by the caudal portion. The pupae are about the same size as the larvae of a bright silvery-brown color, with the spiracles, eyes, a large shield-shaped mark on the dorsal side of the first and second abdominal segments, and small dots similarly placed upon the other abdominal segments and thorax, of a dark brown.

On July 26th, a small moth emerged, and two emerged each day on July 28th, 29th and 30th. These moths were kindly determined for me by Dr. C. H. Fernald as Pterophorus monodactylus Linn., who writes that he has not known of it as having been injurious to sweet potatoes. The growth of the plant is so rapid that the larva is soon left below among the larger leaves. The larva then, in most cases, eats half way through the petiole of a large leaf; the leaf soon wilts and the larva finds shelter beneath the wilted portion. The moths have also been collected in Colorado (Edwards), Salem, Mass. (Putnam), California and Oregon (Walsingham), Texas and Ohio (Zeller),) Illinois and Europe (Dimmock).

The moths are very pretty, silvery-brown insects. The fore-wings are streaked with black and expand about seven-eights of an inch. They belong to the family *Pterophoridae*, commonly known as "Plume Moths," from the fact that instead of having two wings, as do most moths, they seem to have five. I say "seem to have," for they really have but two, the fore-wings being split through the center and the hind wings divided into three parts. Each part of the wing has a broad fringe of hairs on both anterior and posterior margins giving it a feather-like appearance. In repose, the wings are folded together and extended at right angles to the body. When so resting motionless upon a leaf with their long, slender legs held close to the body, they appear exactly like a small, dead twig or piece of grass, and are readily overlooked, the writer having even overlooked them when searching for them in a breeding cage.

Dr. Asa Fitch, New York State Entomologist, was the first American writer to notice this insect (1st. Report 1856, Pg. 144), and in 1856 recorded it as being "taken the forepart of July in yards around dwellings." The moth was described by him as P. cineridactylus, which Lord Walsingham (Pterophoridae of Cal. & Ore. 1880 pl. II, Fig 16, pl. III, Fig. 1), has since determined to be a synonym of P. monodactylus Linn., as is also P. pergracilidactylus Pack. (Ann. Lyc. Nat. Hist. N. Y. 1873, Vol. 10 Pg. 265.) Mr. Geo. Dimmock, who is a student of this family, records it (Psyche Vol. III, 404,

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*(Syn.—Pterophorus monodactylus Linn.—P. Cineridactylus Fitch.,—P. pergracilidactylus Pack.

*I regret that I was unable to make a more detailed description of the live larvae, and now have only alcoholic material.

1882) as very injurious to the plants nearly related to the sweet potato, Convolvulus tricolor and Ipomea purpurea in Cambridge, Mass. Of its habits upon these plants he says: "The larva usually eats into the leaf and flower buds of C. tricolor; on I. purpurea it begins."

Insects of Minor Importance.

Previously Recorded as Injurying Sweet Potato Foliage.

In 1887, Dr. Riley recorded (Insect Life, Vol. 1, p. 987,) a true cricket of the genus Gryllus as being sent him from Catatioula Parish, La., as doing injury to the sweet potato. In reply to inquiry, Mr. Micheal Dempsey, of Jena, wrote him under date of May 7th:—"They infest portions of the hills and swamp lands alike, sweet and Irish potatoes, peas, and tobacco. Our farmers are seriously alarmed at their fearful increase and their destructive habits. Their holes in the ground are promiscuously scattered from a few inches to several feet apart, and are seldom over a foot deep in uplands, although they go much deeper in swamp lands, as the soil is deeper, and the sub-soil softer. They are seldom visible in the heat of the day, and do their cutting at night, taking all they want down into the ground, where they eat as they please. In 1852, I first noticed them eating cotton only, and a few years back they began to eat sweet potatoes. Now they eat peas and tobacco and have attacked our gardens. We find that rapid cultivation, large gangs of poultry and numerous birds keep them in check, but they are becoming too numerous, in spite of all we can do."

Dr. Riley advises a bran mash, such as we have already described for cut worms, and doubtless this would be entirely efficient, as it has often been successfully used in California against grasshoppers.

In his second report of the injurious insects of Missouri, Dr. Riley has also recorded the cucumber Flea Beetle (*Epitrix cucumeris* Harr,) so injurious to the Irish potato, as injurying sweet potatoes. The treatment already recommended for the Sweet-potato Flea Beetle would apply equally well to this species.

The larvae of one of the Spingidae somewhat similar in appearance and habit to the tobacco worm (*Phlegethontius carolina*,) sometimes do serious damage to the foliage. The moth (*Macrosila cingulata*) has therefore been termed the Sweet Potato Hawk Moth. As the caterpillars are large and the injury done by them is very apparent, handpicking has proved to be the best remedy, though also destroyed by Paris green.

THE MARYLAND
AGRICULTURAL EXPERIMENT STATION

BULLETIN No. 60. MARCH, 1899.

Some Diseases of the Sweet Potato and How to Treat Them.

By C. O. Townsend, M. S., Ph. D.

INTRODUCTORY.

The sweet potato is one of the most important crops in certain sections of the State, and since it is subject to numerous fungous diseases, which destroy annually thousands of barrels of these tubers, it has been deemed advisable to present a brief account of some of the more important of these diseases, and to consider some means of controlling them. All the diseases referred to in this bulletin are produced by minute organisms called fungi. These organisms are small plants which are unable (owing to the absence of green coloring matter in their cells) to prepare their own food material, and which must, therefore, depend for their nourishment directly or indirectly upon green plants. If fungi derive their sustenance directly from other living organisms, they are known as parasites, and the plant (or animal) upon which the parasite grows, is known as the host. The parasitic fungus may produce disease in its host in several ways; viz. it may rob its host of a portion of the nourishment that the host has prepared for itself; it may feed upon the living substance of the host; or it may in the process of growth produce a substance which acts as a poison upon the host, thus destroying its life . It is not to be understood from what has been stated that all parasitic fungi produce disease; indeed, some are beneficial to their hosts. Some disease-producing fungi always choose the same plant species for their host, others are able to live just as well upon related species, others flourish upon host plants not at all related, while still others thrive equally well upon either living or dead organic matter. Another important fact in regard to fungi is that they are sometimes able to live equally well upon all parts of the plant, whether above or below the surface of the ground. Keeping in mind these facts in regard to parasitic fungi and their hosts, it will not be difficult to understand the nature of sweet potato diseases and the best means of controlling them. Several cuts have been introduced to aid in understanding the nature and appearance of these diseases, which, since they are produced by different fungi, will be considered separately.

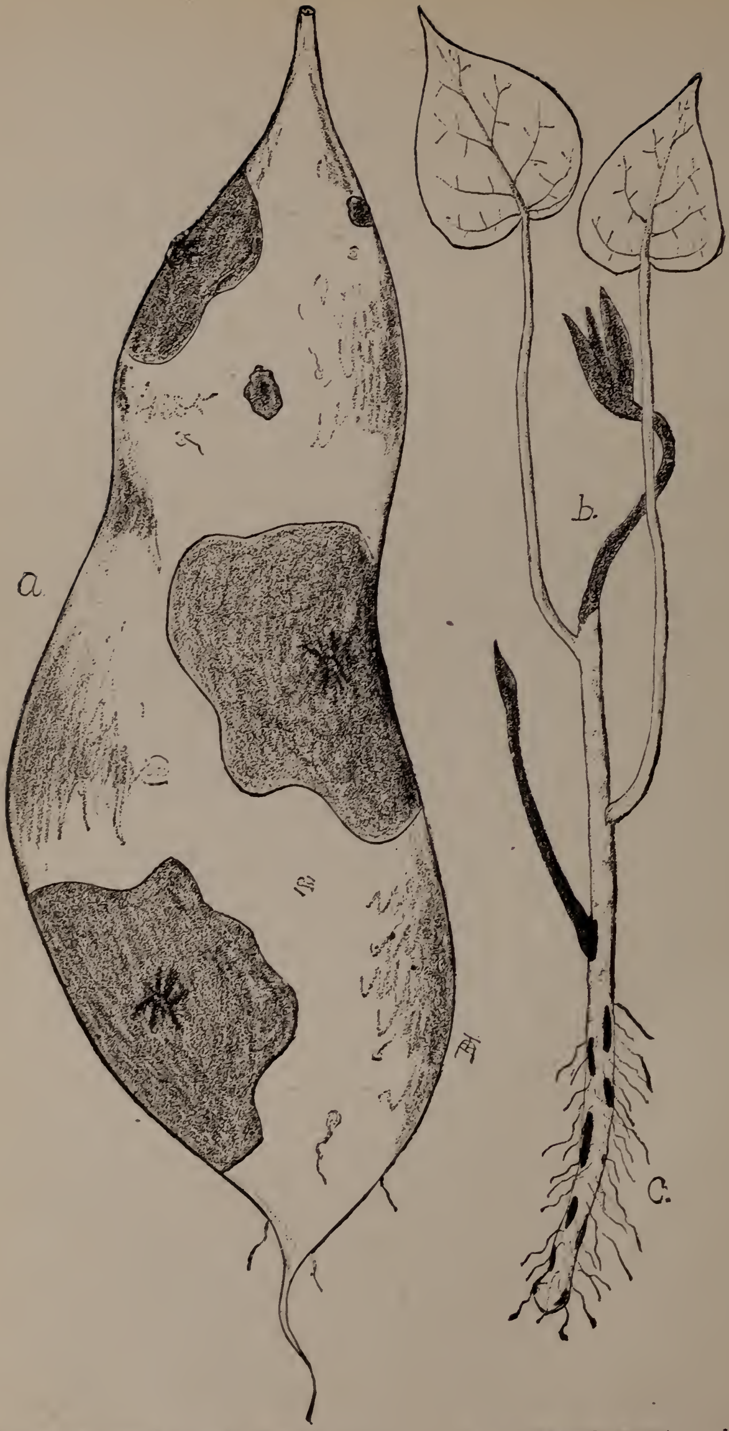

Figure 44.—Black Rot. a, diseased tuber; b, tip of diseased sprout; c, base of diseased sprout. (After Halsted).

Black Rot.

Appearance of Disease.

This disease has been known for many years, but has apparently become more destructive of late, until it is the most troublesome disease of the sweet potato in this State. It is liable to attack the plant at any time during its existance; and even after the crop has been gathered, it often continues its destructive work, doing a vast amount of damage to the stored tubers. Fig. 44, a, shows a tuber that has been attacked by black rot in several places, as shown by the dark patches. The point of attack is at first very minute, and may easily be passed over unnoticed; this is often the case when the potatoes are gathered, but as time goes on the spots increase in size and depth until the whole tuber is destroyed. Fig. 44 b represents the young shoot of sweet potato that has become very seriously affected with the disease. The upper part of the plant has been killed and the lower part, c, is seriously affected, hence we have in this instance a disease capable of affecting any part of the plant.

In Fig. 49, a and b we have another appearance of the black rot in which the root turns perfectly black, as shown by the cross sections in the figure due to the presence of nodules, c, which fill the tissues of the diseased tuber.

Black Rot Fungus. (Ceratocystis fimbriata, Ell. and Hals.)

In order to understand more fully the nature of the disease and the manner in which the attack is made, it will be necessary to examine the following cuts. Fig. 45, a shows a portion of a fungus with branches, upon the end of which two kinds of spores are borne. The end cells of the tapering branches like b fall away and form independent bodies (spores) from which new fungi are formed. Fig. 45, b shows such spores enlarged, one of which has begun to grow. Other branches as at c in the same figure, enlarge at the ends and form a second kind of spore. These spores are much thicker walled than in the preceding case, and in consequence much more resistant, i. e. they do not germinate as readily as the spores b. Spores like those represented at d often spread the disease at once, while those represented by e usually remain in the resting condition for a longer or shorter time, depending upon external conditions. As the spots shown in Fig. 44 a increase in size, and consequently in age, they gradually change their appearance, finally showing a broken spot near the center, which is darker than the rest of the area. If a portion of one of these dark centers be magnified, it will be found to contain a number of flask-shaped bodies with long necks, as shown in Fig. 46. Within the enlarged part of each flask numerous spores different from either of the other kinds are found. When these spores are ripe, they pass up through the long neck of the flask and escape at the free end. They are often held in a mass by means of a gelatinous substance, which escapes with the spores, as shown in Fig. 46, a. These spore masses will dissolve if they are moistened and the spores will float away in the liquid, often finding suitable lodging place for development. Fig. 47, a shows one of the flask-shaped bodies removed from the tissue of the potato and much enlarged; b shows the free end of the neck still more enlarged, spores that were formed in the flask are escaping, and spores of the second class are forming on the surface; c represents some spores of the third class formed and others in the process of formation. Spores of the first and second classes form on the surface of the enlarged part of the flask as well as upon the elongated neck. (See Fig. 48.) It would be very easy to mistake these fungous structures and their spores for different fungi, if patient investigation had not shown that

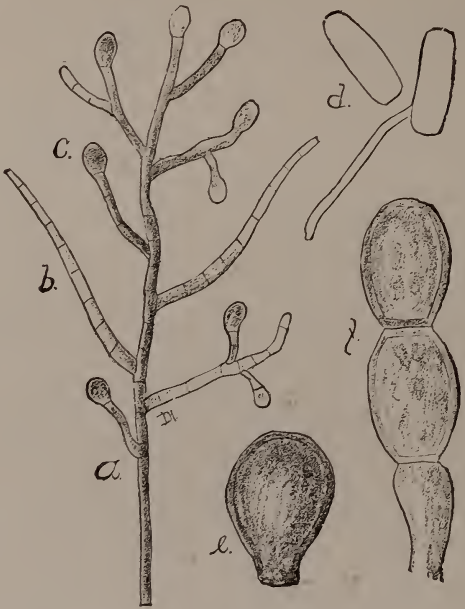

Figure 45.—Black Rot Fungus. a, branching filament; b, branch producing thin-walled spores; c, more resistant spores; d, spores from branch; b, enlarged and free; e, spore c enlarged; f, intermediate form of spore between b and c. (After Halsted).

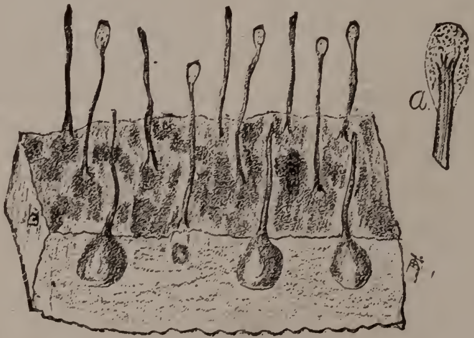

Fig. 46.—Black Rot tissue showing spore conceptacles a, tip of neck more enlarged, showing spores in gelatinous mass. (After Halsted).

they are all the same, only the flask is composed of fibers, so arranged and so compact that a flask-shaped body is formed within which spores are produced. The method by which the spores are formed is shown in Fig. 46, c. The threads of the fungus enlarge and turn dark in certain places forming nodules as shown in Fig. 49, c.

Fig. 50 shows the various stages in the development of these nodules; a represents a fungous thread that has slightly enlarged and divided into a few cells; b, c, d, and e shows the succeeding steps in the process, e being the complete nodule.

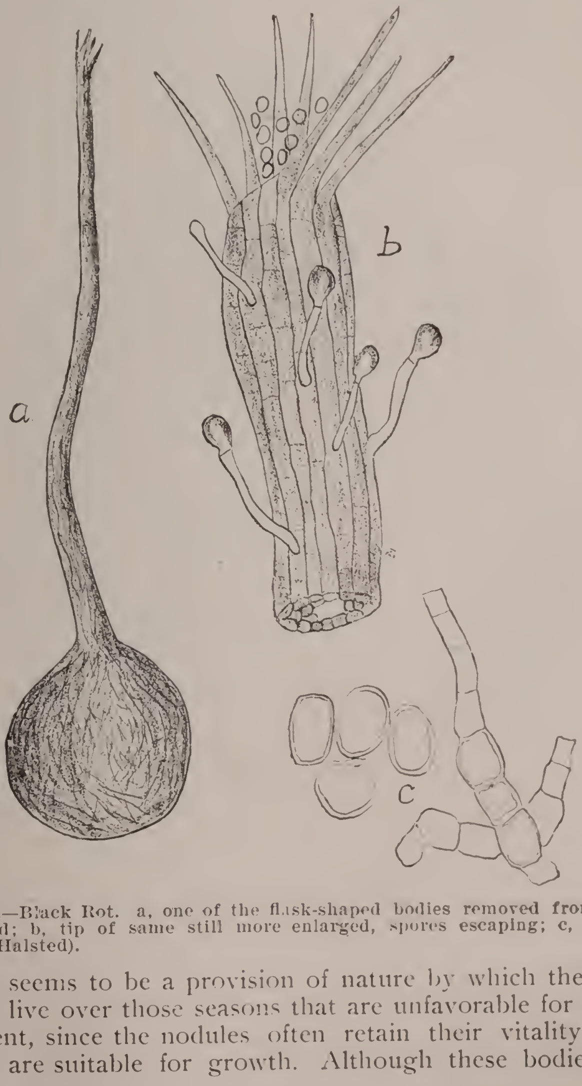

Figure 47.—Black Rot. a, one of the flask-shaped bodies removed from the potato and magnified; b, tip of same still more enlarged, spores escaping; c, spores forming. (After Halsted).

This seems to be a provision of nature by which the fungus is enabled to live over those seasons that are unfavorable for immediate development, since the nodules often retain their vitality until the conditions are suitable for growth. Although these bodies are not strictly spores, they perform the same functions as spores, inasmuch as they are the starting points of new fungi when the conditions for growth are suitable. Upon the surface of these nodules it is not uncommon to find spores of the second class developed as shown in Fig. 51, a.

We see from the preceding cuts and from what has been said in regard to them, that nature has taken many precautions to prevent the extermination of the fungus. Not only is this evident from the great variety of spores produced, but also from the fact that many of the spores or spore bodies are capable of retaining their vitality for an indefinite period. Hence the soil in which potatoes affected with black rot have been grown must become charged, especially with the spores that are formed in connection with the underground part. It is an important fact that only the first and second kinds of spores are formed during the early stages of this disease.

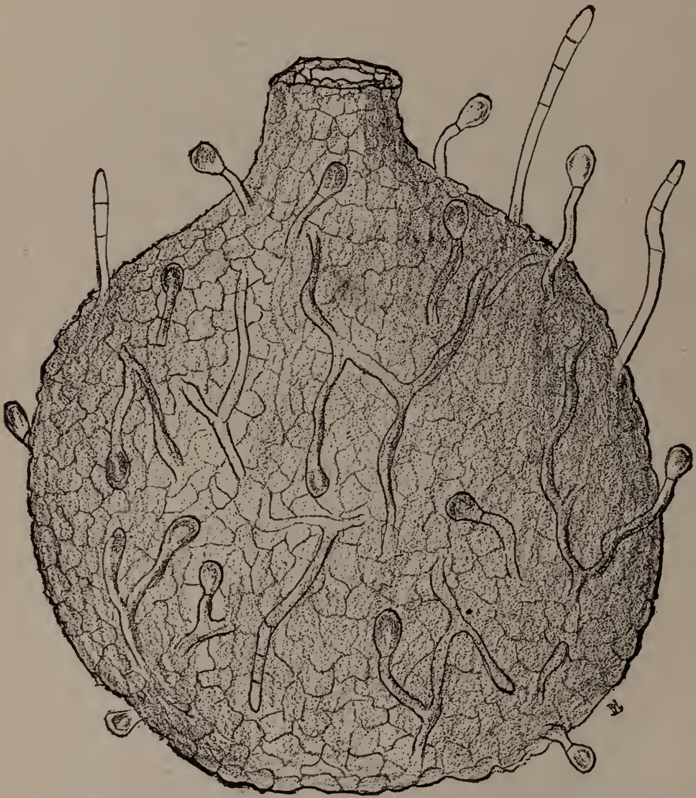

Figure 48.—Black Rot. Base of spore cavity, much enlarged and showing spores upon the surface. (After Halsted).

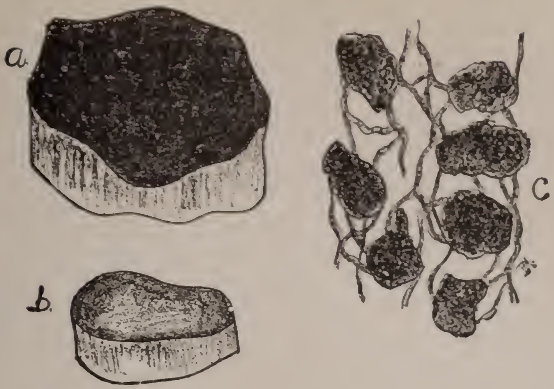

Figure 49.—Black Rot. a, portion of potato; b, same younger; c, portion of a, magnified. (After Halsted).

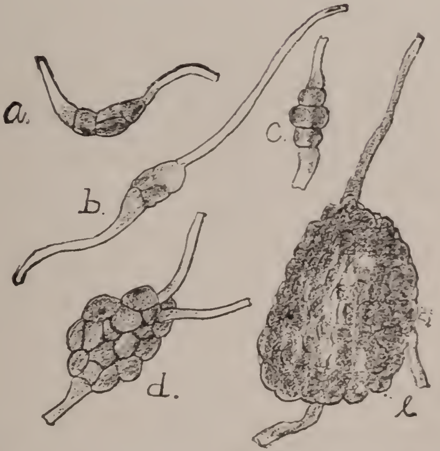

Figure 50.—Black Rot. Development of nodules. (After Halsted).

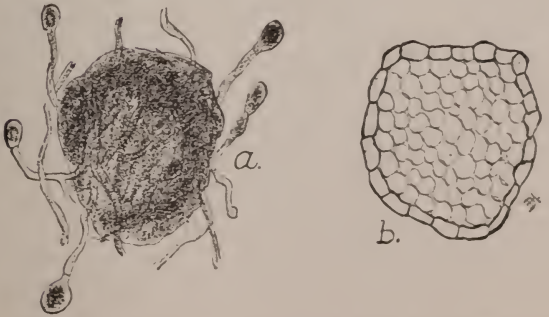

Figure 51.—Black Rot Nodule. a. with spores upon the surface; b. same in cross section. (After Halsted).

Remedy.

Owing to the nature of this disease, as already explained, it is important that every precaution be used to prevent it from getting a foothold. To this end, care should be taken that no diseased tubers be used for producing sets. Young plants should be selected with the greatest precaution, and all diseased or suspicious plants should be discarded. Attention should also be paid to the general vigor of the plant, since a sickly plant is more liable to attack than one that is strong and capable of vigorous growth. If there are no germs of disease in the soil, and the sets are not infected at the beginning, it is not probable that the plants will be attacked by this fungus, but if an attack is feared, the young plants should be sprayed with Bordeaux mixture, which will prevent the development of spores that may be brought into contact with them by the wind or other agencies. Care should also be taken that disease spores are not spread upon the land in manure. As a precaution against this common method of spreading disease, all diseased plants or plant parts should be burned. If, in spite of all precautions, the tubers become affected with the black rot, so that the soil becomes charged with the spores, it will be necessary to rotate the crops, planting no sweet potatoes upon that land for several years, until the fungus is starved out. It often happens that the tubers are so slightly affected with this disease that it is not noticed at the time the potatoes are gathered. In this case the tubers will continue decaying in the bin until they are unfit for use. To prevent this loss, the potatoes may be soaked for a short time in Ammoniacal carbonate of copper, but it is better to examine them carefully before storing, and throw out any that show diseased spots.

Soil Rot.

Appearance of Disease.

This disease is confined to the underground portions of the sweet potato, causing the part attacked to cease growing, a condition which renders the tubers very unshapely, since the parts adjacent to the point of attack continue to grow, as shown in Fig. 52. These roots may be affected at any time during their growth, but the effect upon the development of the tuber is greater if they are attacked while still small, since they are thereby rendered more unshapely and less salable. Fig. 52, a shows a tuber that has been attacked at three points, c, another that was attacked at two points when the tuber was small, thus dividing it into three parts. The point of attack is at the base of a rootlet, as shown in d, where two spots have just begun to form. Only the spots attacked are rendered unfit for use, the adjacent parts remaining still edible and retaining their usual flavor. The attack is usually confined to the surface, and as the diseased part becomes older it often cracks and falls away, the growth of the fungus at that point ceasing.

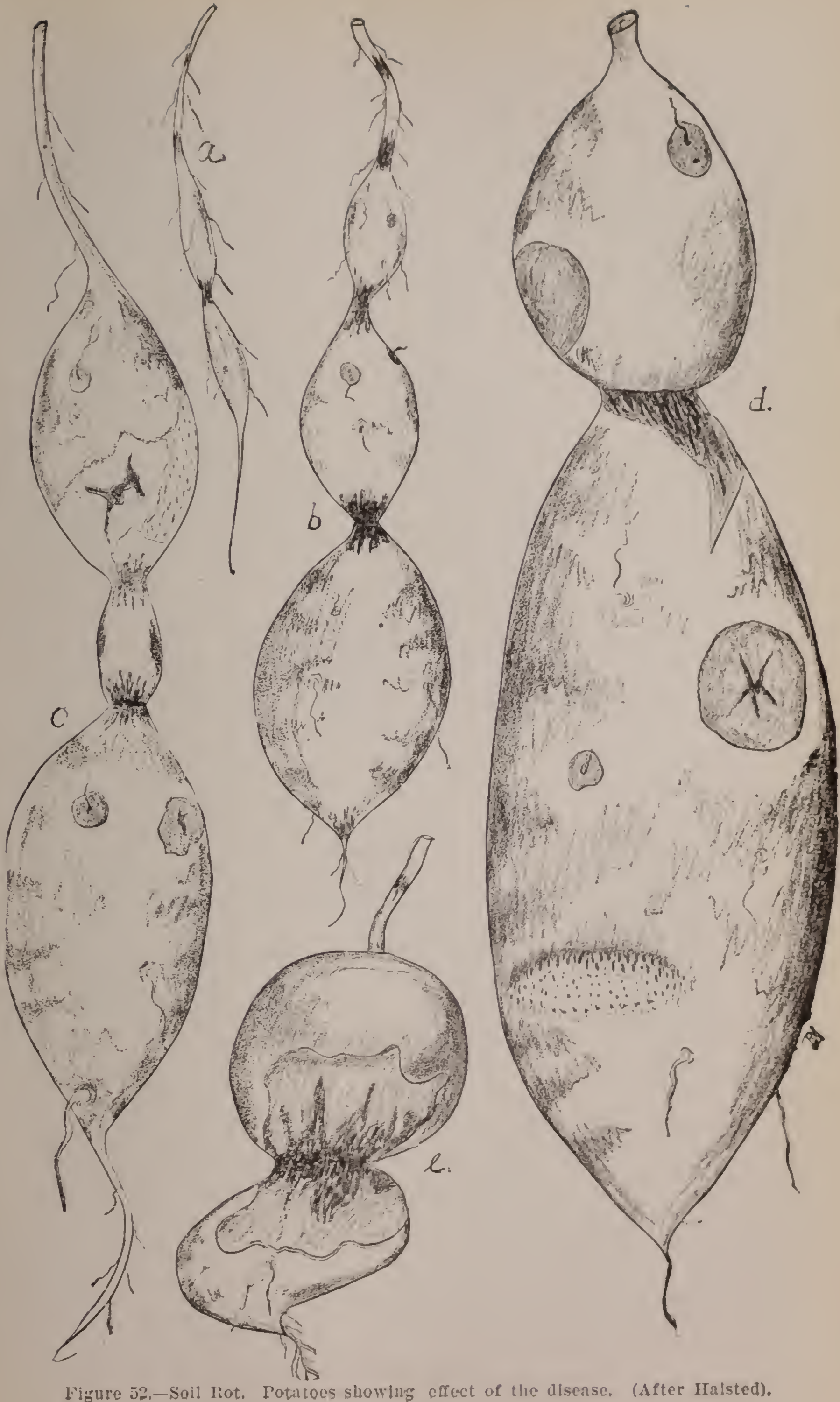

Figure 52.—Soil Rot. Potatoes showing effect of the disease. (After Halsted).

Soil Rot Fungus: (Acrocystis batatas. Ell. and Hals.)

As in the preceding case of Black Rot, soil rot is produced by a distinct fungus, although the two fungi are very different in their habits and in their method of spore formation. The vegetative part consists of elongated, much branched filaments, which extend into the tissues between the cells, thus causing the decay of the tuber at that point, and a consequent cessation of growth. The spores of the fungus are formed in the filaments, as shown at a and b Fig. 53; the filaments become slightly enlarged when the spores are formed; the spores may be few, as in a, or numerous as in b. Sometimes the ends of the filament enlarge and become filled with spores, as in c. When the spores are ripe, the walls of the filament or of the sacs break or dissolve, and the spores escape; d shows one of the sacs collapsed, only a few spores remaining within. The walls of the spores are thicker than the walls of the filament, as shown in Fig. 53, e. This protects the contents of the spores from external conditions, and enables them to remain alive for a long time, when the conditions are not favorable for their germination and development. When the spores are ripe they turn dark, giving a brownish color to the diseased portion of the potato. As soon as the conditions for growth are favorable, the spores germinate and send their thread-like structures into the tissues of the potato, from which they draw their nourishment and soon produce new spores.

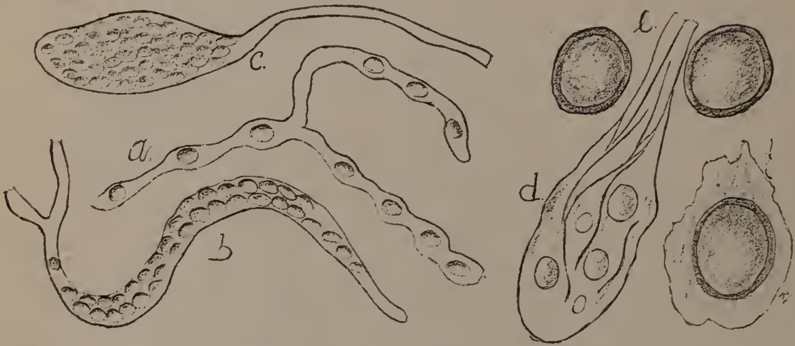

Figure 53.—Soil Rot Fungus. a and b, filaments with spores; c, swollen tip with spores; d, collapsed tip; e, enlarged spore.(after Halsted).

Remedy.

Knowing that the spores of the fungus that produces the disease are formed in or on the tubers, it is apparent that the process of spraying the top would be of no avail in preventing or in curing this disease. Since the disease arises from the spores that are in the soil, it is evident that the trouble may be averted either by so treating the young plants that the fungus is not able to attack them, or by destroying the spores before they are able to produce fungi. Numerous experiments have been performed in accordance with the first method, but with little or no success. Several methods have been employed to destroy the spores in the soil, one of which is the same as that employed for black rot, viz. the rotation of crops. If this method is employed, it is necessary to grow other crops than sweet potatoes upon the soil for a number of years after the soil rot makes its appearance. While this method would undoubtedly be successful if carried far enough, it is not always practicable, since a field that is particularly well adapted to the growth of sweet potatoes cannot well be given up to

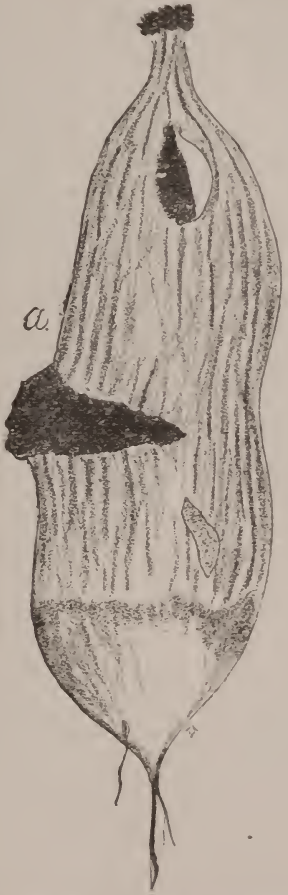

Figure 54.—Soft Rot. Tuber one-half natural size. (After Halsted).

other crops for a long term of years. In the last few years numerous experiments have been carried on in New Jersey under the direction of Prof. Halsted for the purpose of finding some method by which this disease may be controlled. Though the kindness of Prof. Halsted the results of these experiments have been placed at the disposal of the writer. Six substances were tested, viz: lime, sulfur, manure, corrosive sublimate, kainit and copper sulfate. These substances were applied alone in different quantities and also in combinations of two, with the result that while kainit alone has the power to hold the disease in check, sulfur is much more effective. Indeed, when the latter substance was used a crop resulted nearly three times as great as that in the control experiments, in which no remedy was employed, and less than one-third of the tubers produced were marked with the disease, even though the soil was filled with the spores which produce the soil rot fungus. It has been observed that the best results have been obtained when the two substances, sulfur and kainit, are sown broadcast, and thoroughly mixed in the soil where the new roots are to form. In regard to the quantity to be used, Prof. Halsted says that three or four hundred pounds each of sulfur and kainit may be used. While this treatment does not seem to prevent the disease entirely, it tends to reduce it to a minimum, and to give such results in the yield of sound tubers as to warrant its use. While the fungus is the direct cause of this rot, the extent of the damage depends largely upon the weather. The greatest amount of damage is usually done early in the season, and there is nothing to be feared from the disease after the tubers are stored.

Soft Rot.

Appearance of Disease.

This disease appears most commonly after the tubers have been stored, and does not originate upon the leaves or vines. The attack is usually made near the top of the tuber, where it was broken from the vines, and extends downward, often giving to the tuber a somewhat shrivelled appearance Fig. 54. If the skin is broken, a black mass is soon formed, as seen in Fig. 54, a. If the skin remains intact, there may be no indication that the tuber is diseased, but if it is broken, the black mass soon forms. Another characteristic of this disease is the disagreeable odor which is emitted by the decayed substance.

Soft Rot Fungus: (Rhizopus nigricans, Ehr.)

As in the two preceding cases, the disease is produced by a well defined fungus, the main features of which are shown in Fig. 55. In a is shown a small portion of two fungous threads as they appear in connection with a few of the cells of the potato b. These threads are much branched and thus present considerable surface. The injury to the tuber is produced not so much by the amount of material absorbed by the fungus, as by a substance which it excretes, and which causes the starch in the potato cells to dissolve and the cell walls to decay more or less completely. Fig. 55, c shows a whole fungus, which produces soft rot. The part below g grows into the tissue of the potato, as shown in a and produces the damage, while the upper part is designed for the reproduction of the plant. This upper part grows towards the light, and under proper conditions the stalks enlarge at the ends to form globular sacs, the contents of which break up to form a large mass of spores. If the skin of the potato is not broken it is possible for the fungi to grow all through the tissue of the potato without producing any spores, but if the skin is broken, stalks are soon pushed out upon the ends of which the spore sacs are formed. When ripe, these spore sacs filled with spores are dark colored, and this gives the black appearance to the mass, as shown in Fig. 54, a. One of these spore sacs filled with spores, is shown at d, another one, which is older, and which has broken, allowing nearly all of the spores to escape, is seen at e; while a still older and completely empty one is seen at f. Some of these spores are shown at h, one of which has begun to germinate.

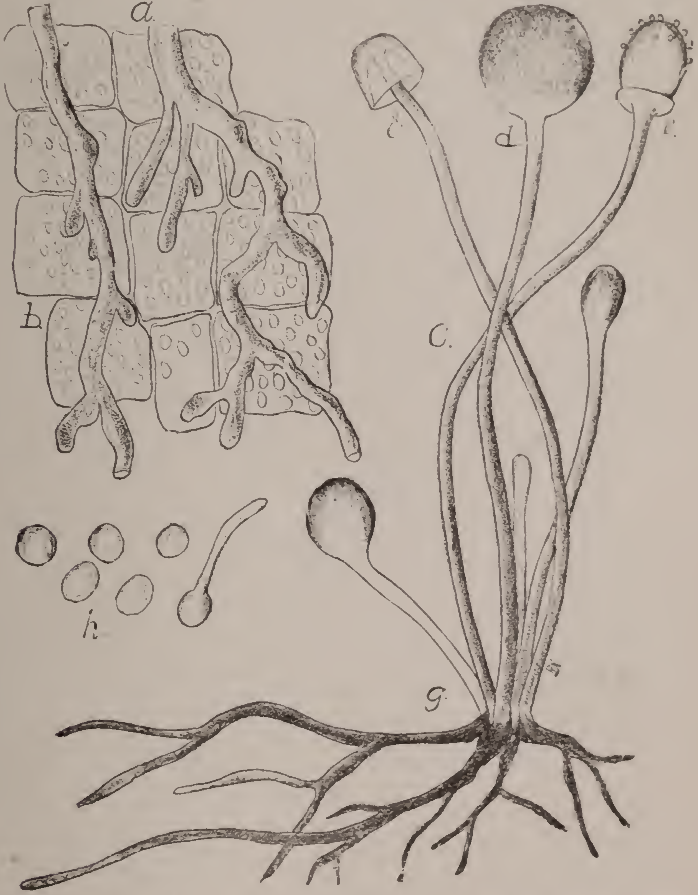

Figure 55.—Soft Rot Fungus. a, fungus threads; b, cells of potato; c, mold fungus much enlarged; d, spore capsule; e, older state; f, collapsed capsule; g, base of mold plant; h, spores. (After Halsted).

All of these figures are, of course, greatly magnified. In order to produce this disease, it is necessary for only a few of these spores to lodge either at the point where the tuber was broken from the vine or upon some point on the tuber where its skin is broken. As soon as the condition of temperature and moisture are suitable, the spores will germinate and the disease is established. The disease itself can be spread from tuber to tuber only by means of the spores, but the juice from a decayed potato may cause another potato with which it comes into contact to rot. This arises from the fact above stated that this fungus produces a substance which causes the decay of the cells of the tubers.

Remedy.

Since this disease rarely occurs until after the tubers are stored, it is useless to spray the plants in any stage of growth for soft rot. There are a number of precautions, however, which, if strictly observed, will retard to a very large degree the ravages of this pest. Great care should be taken against bruising the tubers or breaking their skins while gathering and storing them, since we have learned that it is where the skin is broken that the fungus finds a foothold. It is also important that the tubers should be kept at a proper temperature after storing, i. e. from 70 to 80 degrees. This requires some kind of heating apparatus, which may be kept constantly in operation, and which is easily adjusted. Furthermore, the potatoes should be stored in a dry place, since moisture is an essential condition for the development of the fungus. The Louisiana Experiment Station recommends the use of fostite (a powder composed of copper sulfate and soap stone), which sprinkled over the potatoes in the bin prevents the spread of the rot. Even after all these preventive measures have been employed, the stored tubers should be watched, and those that are diseased should be removed from the bin as soon as they are detected. Especial attention should be given to these precautions during the sweating period after they are stored.

Stem Rot.

Appearance of Disease.

Stem rot makes its appearance in the stem close to the surface of the ground, and extends in both directions. The influence of the rot extends much farther than the fungus which produces it, for example, the vine turns yellow and finally dies as a whole, unless it has produced roots at one or more of its joints, in which case the vine remains green from the rooted joint to the tip. Hence the death of the vine is produced by the decay which takes place near the surface of the ground, since the rest of the vine is thereby cut off from the supply of food and moisture. While the vines are dying from the effects of this fungus, the disease is extending downward into the roots, and causing more or less complete decay of the tubers. This explains the fact that the decay of the tubers begins almost invariably at the top as seen in Fig. 56, in which different stages of the decay are shown. Often the partially decayed tubers send up new shoots, as shown in a and b, Fig. 56.

This second growth of shoots does not succeed in producing new tubers, and, in short, a hill which has suffered from stem rot is practically worthless.

Stem Rot Fungus (Nectria ipomocae. Ell. and Hals.).

The vegetative part of this fungus spends its existence within the tissue of the host plant. The spores are formed within elongated, sac-like bodies, and these in turn are enclosed in flask-shaped cavities. These cavities form elevations on the surface of the affected parts(which usually appear as flesh-colored clusters). The spores are usually produced in definite numbers within the sac (commonly eight), and each spore is double, i. e. composed of two cells.

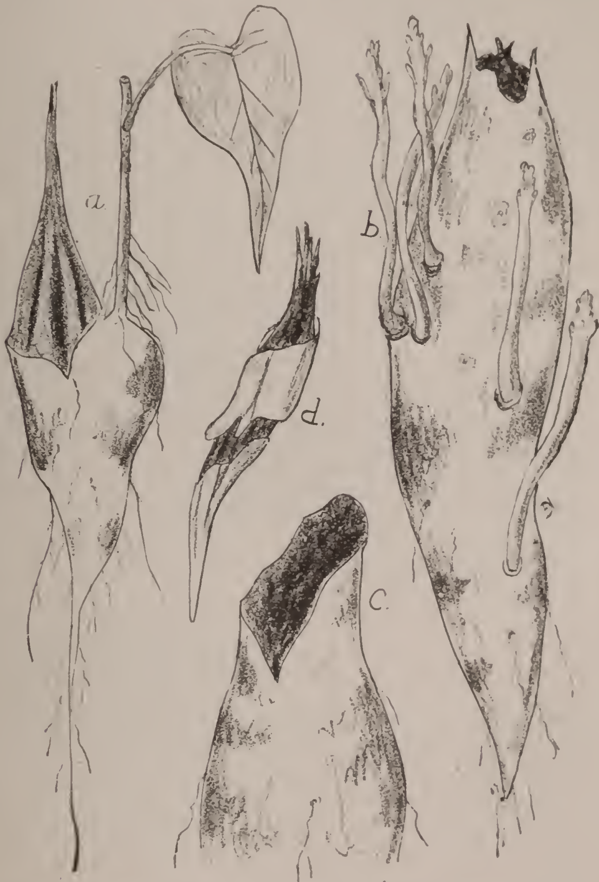

Figure 56.—Stem Rot in its different stages. (After Halsted).

Remedy.

Since this disease is produced by the spores in the soil, the same general treatment mentioned in the preceding cases should be employed, viz. rotation of crops with long intervals between the crops of sweet potatoes; cultivation and fertilization, so that the sweet potato plants may be strong to resist the attack of the fungus. Various treatments of the soil have been suggested. It is certain that if the soil could be sterilized by subjecting it to a high degree of heat, the spores could be destroyed. The only difficulty here is the method by which the proper degree of heat could be applied to a considerable area of ground and for a sufficient length of time to destroy the germs. There is, so far as known, no practical method for destroying these spores, except to starve them out by rotation, as stated above.

White Rot.

Appearance of Disease.

This disease attacks the tubers, causing them to assume a white, dry, chalky appearance. The attack is first noticed in the form of a slight depression at the base of one or more of the hair-like rootlets. These diseased areas enlarge and deepen until possibly the whole potato is of a chalky consistency. The potatoes affected with the disease emit no odor, and if the skin is not broken, they may be entirely overlooked. If we cut through one or more of the depressions mentioned above, we shall find that these spots consist of white, chalky matter, underlaid by a darker tissue, as seen in Fig. 57, a. It is in the tissue underlying the white spots that the fungus lives, which produces this chalky substance and transforms the living tissue of the potato.

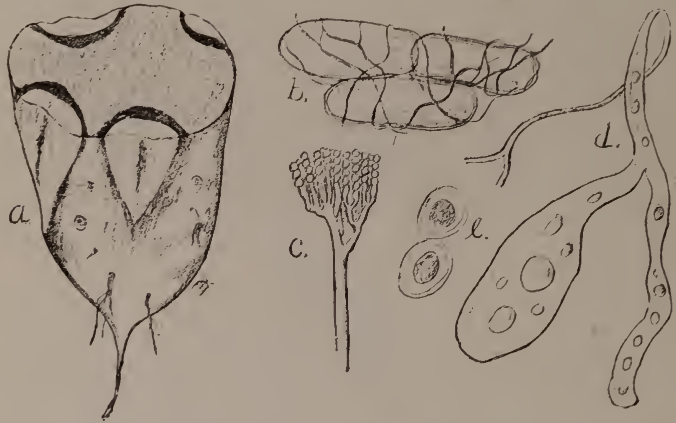

Figure 57.—White Rot. a, portion of diseased potato; b, cells of potato and fungus threads; c, spore formation; d and e, second spore development. (After Halsted.)

White Rot Fungus.

The vegetative part of the fungus is composed of very fine, thread-like tubers, which branch copiously and extend in all directions between the cells of the host plant Fig. 57, b. Under favorable conditions these threads find their way to the surface; send up long, vertical tubes which form a number of branches on the free end, and which in turn produce a chain of spores Fig. 57, c. A second class of spores is formed within the thread-like structures of the fungus. For this purpose the fungus threads may enlarge at any point, but it is more common for them to enlarge at the ends, as shown in Fig. 57, d.

These spores as shown at e are thicker walled, and hence much more resistant toward external conditions than are the spores of the first class. Sometimes this fungus forms moldy spots on the surface of the potato, these patches assuming a bluish color very similar to the molds that grow on bread, preserves, and other organic matter.

Remedy.

Since the spores of this fungus are produced on the tuber, it is not surprising that they should remain in the soil ready to attack the next crop of sweet potatoes. Hence, in order to prevent the ravages of this disease, it is necessary to rotate crops, and thereby to starve out the fungus. Care should also be taken that all of the sets are healthy; thus reducing to a minimum the probability of transmitting the disease to the field along with the sets, and at the same time doing away with the weakest points of attack which are always the sickly plants.

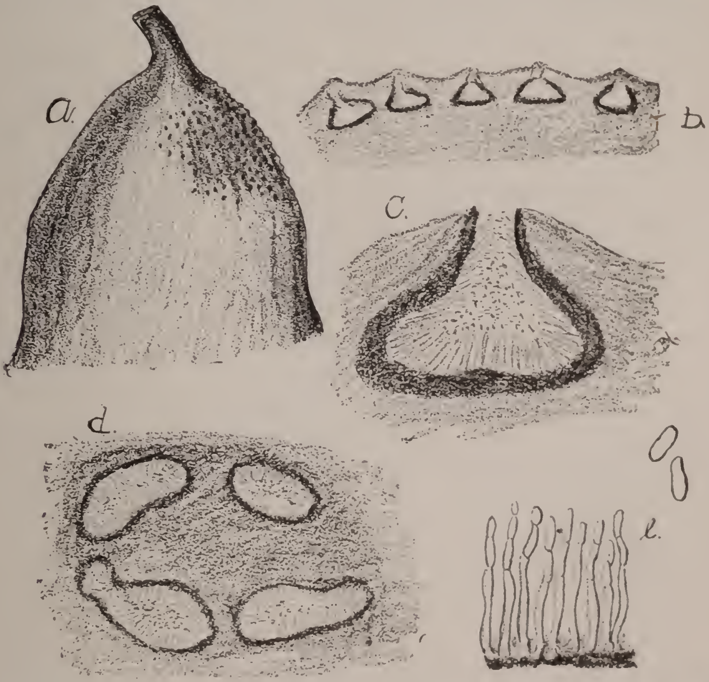

Figure 58.—Dry Rot. a, portion of diseased potato; b, section showing fungus pits; c, same enlarged; d, interior spore formation; e, spores and filaments within the pits. (After Halsted).

Dry Rot.

Appearance of Disease.

This disease attacks only the underground portions of the plant, beginning usually with the upper ends of the roots and gradually extending downward. Soon after the tubers are attacked they become wrinkled and the surface becomes covered with innumerable pimples, while the interior of the potato assumes a dry, powdery consistency. Fig. 58, a shows a portion of a typical tuber affected with dry rot.

Dry Rot Fungus. (Phoma batatae, Ell. and Hals.).

The fungus which is the real cause of the dry rot penetrates the tubers and draws therefrom its nourishment. The vegetative part of this fungus is composed of slender, thread-like filaments which grow rapidly and soon form small cavities in the skin of the potato just below the surface. These are represented on the surface by the pimple shown in Fig. 58, a while b in the same figure, shows the cavities in section and somewhat magnified; c represents one of the cavities still more highly magnified; it is a flask-shaped cavity with a rather short neck and dark wall, within which are produced the spores of the fungus. The spores are borne on slender stalks, which are pushed out from the vegetative part of the fungus into the flask-like cavities, d, representing some of the flasks cut horizontally, while e shows, highly magnified, some of the spores and the end stalks upon which they are borne.

Remedy.

Since the diseased tubers may be easily detected by their pimply appearance, it is not difficult to separate them from the sound potatoes. This step should be taken as soon as the tubers are gathered, and all diseased roots should be burned. Care should be taken that these diseased roots are not left in the field, as this will undoubtedly fill the soil with spores, and thus insure an attack on the succeeding crop.

Scurf.

Appearance of Disease.

Scurf is found only in the underground portion of the sweet potato plant, and begins as a tiny, light brown speck upon the surface of the tuber. This speck gradually enlarges until possibly the whole tuber assumes a rough appearance and a dark color, and if the attack is severe, the tuber appears somewhat shrivelled, Fig. 59, a. If we cut one of the affected potatoes, we shall see that the disease is confined to the surface of the tuber, and that the interior is still edible. Hence, while the disease does not destroy the crop it greatly decreases its market value.

Scurf Fungus: (Monilochaetes infuscans, Ell. and Hals.)

In Fig. 59, b are shown some of the cells from the surface of a diseased tuber, and also several of the fungus filaments. These filaments, which are composed of chains of cells, as shown in the figure, penetrate the skin of the tuber, and grow rapidly among the surface cells. The fungus draws its nourishment from the cells of the potato, thus causing the surface to shrivel and turn dark.

Some of the fungus filaments are pushed out, as shown in b, so that they extend above or lie upon the surface of the tuber. One of these filaments still more magnified is shown at c. This part of the fungus turns brown and gives additional color to the diseased portion of the potato. It is from this portion of the fungus lying outside of the potato that the spores are produced.

Remedy.

Close examination should be made of the roots from which the sprouts are to be produced, in order that the disease may be avoided. It is probable that soil and weather conditions have considerable to do with the extent of damage done by this pest, although it is clear that the fungus must be present in order to produce scurf. Hence, if the spores are in the soil, it would be advantageous to rotate crops.

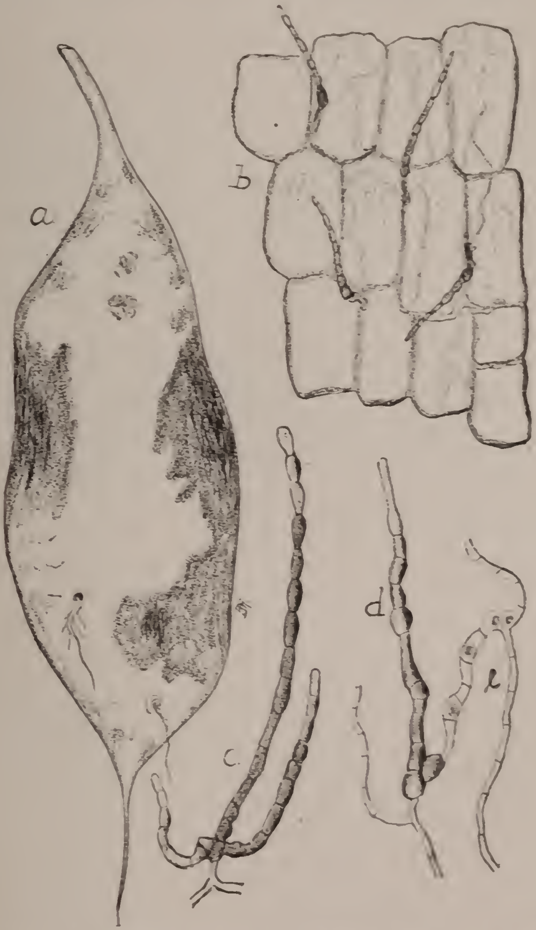

Figure 59.—Scurf. a, diseased potato; b, magnified surface; c, d and e, filaments of fungus. (After Halsted).

Leaf Mold.

Appearance of Disease.

As the name implies, this disease attacks primarily the leaf of the sweet potato, although it may attack the stem also. While it affects the underground portion in an indirect way, the damage done in reducing the number and size of the tubers is often considerable, since the whole plant depends upon the leaves and stems for the production of food material. In the first stages of the disease, the leaves assume a pale, sickly color. This is followed by the appearance of brown spots upon the upper surface, and white patches (spore masses) upon the under surface of the leaves. The leaf in Fig. 60, a shows several of the spots produced by this disease.

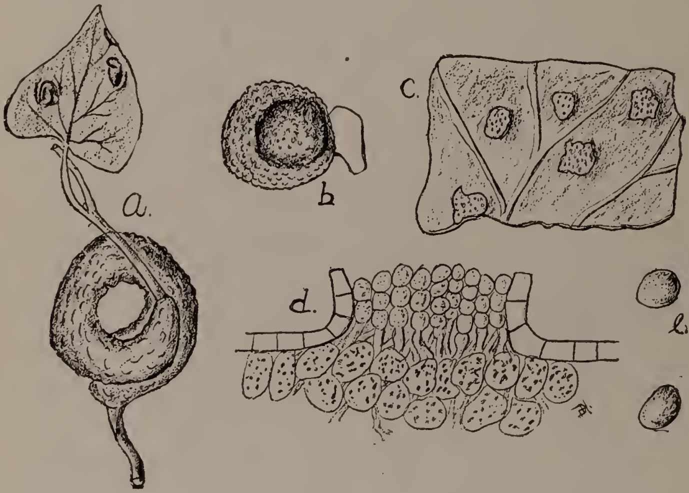

Figure 60.—Leaf Mold Fungus. a, leaf and vine affected; b, winter spores; c, portion of leaf affected; d, section through spot: e, summer spores, highly magnified. (After Halsted).

Leaf Mold Fungus: (Cystopus ipomoeae—panduranae.—Farl.*)*

The vegetative part of this fungus is composed of fine filaments which grow among the leaf cells, absorbing from the host plant the nourishment necessary for the growth and development of the fungus. These filaments increase rapidly and break through the surface of the leaf, as shown at d, and on the ends of the filaments thus exposed to the air and light are formed numerous spores. Two of these spores more highly magnified are shown at e. They are comparatively thin-walled, and under favorable conditions will soon germinate and produce new fungi. The fungus which causes Leaf Mold is not confined to the sweet potato, but may attack a large number of allied species. While growing upon some of these closely related species a second form of spores is produced. Owing to the thick walls which these spores possess, they are able to resist the external weather conditions and thus to live over from one summer to another. This second class of spores, called winter spores, is produced in the swellings which appear upon the stems, as shown in Fig. 60, a. When these swellings break up in the spring, the spores are set free, and as soon as conditions are favorable, the fungus will attack any of the related plants with which they come into contact.

Remedy.

Destroy all the worthless species of the morning-glory family, of which the sweet potato is a member, so that none of the winter spores may be produced. At the first indication of this disease upon the sweet potato plants, spray with Bordeaux mixture to prevent its spread.

Summary.

All the diseases described in the foregoing pages are produced by small parasitic plants called fungi. A fungus is composed of two parts, viz., vegetative and reproductive. The vegetative part is composed of thread-like structures which are hollow, and which grow in or on the tissues of the diseased plants. The reproductive part consists of small, round or elongated bodies, called spores, which have the ability under favorable conditions to produce new fungi. The spores are produced in different ways by different fungi, and some of the fungi are able to produce spores in several different ways. Some spores are much more resistant than others and are capable of retaining their vitality for several years if the conditions for germination and growth are not favorable.

Black Rot:—Both stem and root liable to be attacked by this disease. Causes the diseased part to turn black, as the name signifies. May attack the young sets in the bed or it may not appear until the plants are in the field.

Remedy:—Discard all diseased sets, spray with Bordeaux mixture if an attack is feared, and do not plant in the same field where the disease appeared last season.

Soil Rot:—Attack is confined to the roots and tubers, giving to them the appearance of a string of beads of irregular size and shape.

Remedy:—Rotate crops. Treat the soil with sulfur four hundred pounds to the acre, sowed broadcast, and worked in. To the sulfur may be added with advantage the same amount of kainit.

Soft Rot:—Attacks tubers, usually after they are stored. Tubers shrivel. Black masses when skin is broken and disagreeable odor.

Remedy:—Avoid bruising the tubers, store in dry places at a temperature of about 70 degrees, remove and burn diseased tubers as soon as they begin to decay.

Stem Rot:—Dark lines appear on the stem just at the surface of the ground. Vine turns yellow, then black throughout, unless rooted at some node, beyond which it remains green. Disease extends downward, and causes upper part of tuber to decay. Short shoots from partly decayed tubers.

Remedy:—Rotate crops. Use only vigorous sets.

White Rot:—Attacks tubers only, giving them a white, chalky appearance.

Remedy:—Rotate crops. Use only vigorous sets.

Dry Rot:—Attacks underground parts only, giving to them a wrinkled, pimply appearance. Interior of diseased tubers becomes dry and powdery.

Remedy;—Gather and burn all diseased roots at the time the crop is harvested.

Scurf;—Attacks underground portion only, giving to them a rough, brownish, and sometimes a shriveled appearance.

Remedy;—Discard all diseased tubers in producing sets, and rotate crops.

Leaf Mold;—Leaves become sickly, brown spots appear upon their upper surfaces, and white spots upon the under surface.

Remedy;—Destroy all related weeds. Spray with Bordeaux mixture.

Note;—All sweet potato growers who are troubled with any diseases of this plant will confer a favor upon the writer by communicating with him in regard to the matter.

In conclusion, the writer wishes to express his sincere thanks to Prof. B. D. Halsted, of the New Jersey Experiment Station for the cuts used in this bulletin, and also for other assistance rendered.

THE MARYLAND
AGRICULTURAL EXPERIMENT STATION

BULLETIN No. 61. JUNE, 1899.

The Sugar Beet in Maryland.

By H. W. Wiley, Chief Chemist U. S. Dept. of Agriculture.

HISTORICAL.

The establishment of a beet sugar factory in Wilmington, Del., in 1879, and the subsequent financial losses attending the venture, discouraged the Maryland farmers from undertaking an investigation of the possibilities of sugar beet culture in their State. Had the factory at Wilmington met with success, it would have been a proof of the possibility of establishing a successful beet sugar industry in Maryland. The great similarity of soil and climate between the two states indicates that what is true in a general sense of one locality is applicable to a greater or less extent in the other. Nevertheless the general interest which was aroused in connection with the beet sugar industry, at the time of the establishment of the factory at Wilmington, had its influence in Maryland.

Shortly before the time mentioned above, the Maryland Farmer, for 1874, Vol. 11, page 70, recommends that the sugar beet be cultivated in Maryland for cattle food. In the same journal for May, 1874, page 130, directions are given for the planting of sugar beet seeds. It is recommended that these seeds be planted before the 10th of May,that they be soaked before planting and that the rows be rolled, after sowing with a drill, by a hand roller, in order that the earth be pressed about the seeds, thereby hastening germination. The same journal for the month of June of the same year, has an article on the culture of the sugar beet and its value as a cattle food. This suggests that the sugar beets be thinned in the rows until they are about a foot apart and that in plowing the earth be thrown against the plants. Reference is

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Note: All the experimental work on sugar beets conducted by this Station has been in co-operation with the Division of Chemistry of the United States Department of Agriculture. The preparation of this matter for a bulletin has been authorized by the Secretary of Agriculture and Office of Experiment Stations.

H. J. PATTERSON, Director.

made to the European practice of level culture, but it is stated that with such culture the beets are apt to grow out of the ground. The yield of sugar beets in England is reported at the rate of seventy-two tons per acre, which is doubtless a wild exaggeration. The sugar beets and other root crops, it is stated, are essential to success in raising and fattening cattle and as a healthful food for milk cows, making a palatable change of diet from dry hay and grain. They also greatly promote the flow of milk in winter.

It is recommended on page 132 of the same journal for 1875, that land be prepared for sugar beet culture by fertilizing with 250 pounds of good superphosphate, and that a mixture of plaster, salt and ashes or fine bone dust, at the rate of about twenty bushels per acre, be applied on top of the soil after the planting is finished. It is recommended also to allow the plant to reach the height of six inches before thinning, and that in the thinning process the plants be transplanted to the vacant spaces in the row. It is stated that beets do well when transplanted, which is hardly in harmony with modern experience. On page 79, of the Farmer for the same year, it is stated that in Austro-Hungary from twelve to fourteen tons of sugar beets are produced per acre, yielding an average of thirteen per cent of sugar. A cut of a section of a sugar beet is given, showing the portion which is richest in sugar. It is stated that beets weighing about one pound are to be preferred. A line is also shown in the cut indicating the point at which the crown should be removed. Reference is made to the use of the pulp of the beet sugar factories for feeding cattle. It is recommended that from sixty to seventy pounds of pulp be fed to each animal with from six to eight pounds of meal per day. The most successful beet production, for sugar making purposes, is stated to have been obtained where the rows were sixteen inches apart and the plants six inches apart in the rows. A fertile loamy soil is best.

In the issue of the Farmer for July, 1877, Mr. Burnett Landreth gives some statistics in regard to the culture of the sugar beet in Europe. He states that the average production of beets reaches as high as ten tons per acre, yielding an average of over one ton of sugar. In Germany the average of sugar extracted is 9 1-10 per cent. The editor makes the following comments on Mr. Landreth's statements: "It is a great and profitable industry, but as has frequently been shown in the Maryland Farmer, watermelons are a more profitable crop to raise for making sugar." It is rather strange that the unfitness of watermelons for sugar making purposes was not known at that time.

In 1876-77 Delaware appropriated money to be expended in premiums, amounting in the two years to $1,800, and the result was the subsequent establishment of the sugar factory at Wilmington. An active interest was taken in this matter in many localities, particularly by the people of Baltimore, Md., but no attempt was made to grow the beet on a large scale for sugar making purposes nor to establish a factory.

In the Maryland Farmer for August, 1878, there is found an article by George M. Powell on beet sugar, in which it is stated that, "There is no material subject now engaging the attention of our countrymen of more vital importance than beet sugar." On page 271 there is an article, copied from the "Evening News," of Baltimore, entitled, "Probable introduction of a new and important industry in Maryland." It is stated that "The Pacific Slope and the Atlantic Slope and the Eastern States all have soils which have proved highly suitable to the growth of the sugar beet. Many localities in the Soutern States, where this root can be grown, may be included." * * * "In Europe, in California and in Maine, indeed, everywhere it has been tried, the growing of the true sugar beet and its manufacture into sugar has proved profitable to the growers and highly remunerative to the capitalist who invested in the manufacture." In commenting on this article, the editor of the Maryland Farmer said: "We hope that the manufacture of sugar from beets grown in Maryland, will be an accomplished fact before the year 1879 closes."

In the issue for October of the same year, is a paper on "Beet Sugar" by George May Powell, which was read before the Agricultural Section of the American Institute, in New York City, on August 27th. As long ago as 1878, it is seen from a perusal of Mr. Powell's paper, the newspapers were making statements that the simple apparatus used in the manufacture of cider and in making sugar from maple sap, are sufficient for making sugar from beets. He, however, shows the falsity of such statements and also points out the failure which attended the attempts of making sugar out of maize stalks. Mr. Powell advises the establishment of drying kilns in different parts of the country, where beets can be dried and the dried chips sent to sugar refineries for sugar making purposes. Mr. Powell had a very extended idea of the areas suitable to beet culture in this country. He says: "From the Canada line almost down to the Gulf of Mexico good sugar beets can be raised. * * * The mountainous western parts of the Carolinas, and the eastern parts of Kentucky and Tennessee, as well as Maryland and the Virginias, are perhaps quite as good as the New England and Middle States. * * * In many, if not in all of these regions, beet sugar is soon to become one of the greatest of our national industries."

In the issues of the Farmer for November and December there is an interesting history of beet sugar in the United States, written by Mr. Ernest T. Gennert. An amusing letter is found on page 383 of the issue for December, 1878, from Mr. Andrew H. Ward. He says that, "the beet juice is boiled down the same as maple sap, sorghum or cane juice, requiring no more labor or skill, and can be done as economically on the above quantity (725 bushels) as on a large amount. It needs no costly machinery, such as centrifugals, hydraulic presses, vacuum pans, or filtration through bone coal, etc." Mr. Ward further says: "The present cider mills and cheese factories could add to their present machinery the pans or presses, as required, and by co operation on this, as in regard to other products, we can produce profitably all the sugar we need."

An article, quoted from the Baltimore American, in the issue of the Farmer, December, 1878, refers to the recent failure of the Calvert Refinery, and suggests that the present condition of affairs affords an opportunity to inaugurate the manufacture of beet sugar, and the success attained by all the nations of Europe that have embarked in this industry proves the practicability of the enterprise.

About the year 1879, interest in the beet sugar industry became general throughout the United States. This was largely due to the investigations made by the Department of Agriculture under the direction of Dr. William McMurtrie, who immediately before this had been the chemist of the Department. Dr. McMurtire was also the representative of the United States Depatment of Agriculture at the Paris Exposition in 1878. He was the author of a most interesting and valuable report on beet culture, which was published by the Department in 1879.

The venture in which the people of Maryland were most interested was the one started in Delaware. It was perhaps unfortunate from a superstitious point of view that the Delaware Beet Sugar Manufacturing Company was organized on April 1st, 1879. The directors were among the most influential men of the State and the first board consisted of Geo. G. Lobdell, William G. Gibbons, Lea Pusey, Geo. W. Bush, William G. Pennypacker, Geo. W. Stone and Alfred W. Warner. In an article published by the newspaper, Every Evening, of Wilmington, Del., it is stated that the directors did not deem it necessary to build their factory until the first crop of beets was raised. It is further stated that the company intends manufacturing sugar from dried beets, using only such green beets as may be grown contiguous to the factory. An amusing illustration of the popular ignorance concerning beet manufacture is shown, where, it is stated, "Another advantage derived from using the dried beets is that they do not require evaporation." The beet seed employed was known as the "German Imperial," and the capacity of the proposed factory was fifty tons of beets per day, turning out five tons of sugar per twenty-four hours. The Maryland Farmer, in commenting on the above article, asks: "How long is it to be before Marylanders will engage in this new and great national enterprise?" In the light of history I have no doubt that the Marylanders are extremely glad that the time of their engaging in this new and great national enterprise was postponed.

The Aegis and Intelligencer, of Belair, reports a meeting of the farmers of Harford county, Maryland, held on the 5th of April, 1879, at the house of Mr. C. C. Kinsey, W. A. Heaps presiding and W. Scott Whiteford acting as secretary. It was proposed at this meeting to raise $15,000 as capital for the erection of a beet sugar factory in Harford county, consisting of 750 shares, at $20 each, one-third of which was to be payable in beets. This seems to have been the first organized meeting in Maryland to secure the location of a sugar factory.

The Baltimore American for September, 1879, contained a leading article on the beet sugar industry, urging its establishment in Maryland. It was urged that the prices of coal and of all the ingredients used in refining sugar were as cheap in Maryland as in Germany or France and that, "above all, the nature of the soil in Maryland and Virginia is believed to be better adapted for raising the sugar beet than that of Germany."

According to the Belair Aegis and Intelligencer of September, 1879, Mr. Richard B. McCoy, who had been president of the Harford County Sugar Beet Association, visited Wilmington in September, 1879, in the interests of the Harford County Association. Mr. Lea Pusey made an offer to him to buy beets in the green state from the Harford County farmers, at the price of $4 per ton, to be delivered at any of the stations of the Philadelphia, Wilmington and Baltimore Railroad. A contract was made with that railroad to deliver beets from Harford county to Wilmington, at a reduced rate of freight. It is evident from the report given that considerable quantities of beets had been planted in Harford county, since it is stated that the crop promised to be a good one, although the dry weather had operated against it.

In the Baltimore Sun of October, 1879, it is claimed that, "Baltimore is in a superior position for a beet sugar centre. She has great advantages over all German ports. Maryland, owing to its long growing season could give larger growth and more saccharine value to the beets than Germany."

In the same journal data are given concerning the cost of drying the beets. It is evident from the literature of the time, that the prevailing opinion in regard to this industry, was that the beets should be sliced and dried before shipment to the factory. This is shown by an article in the Baltimore Sun, copied in the Maryland Farmer for July, 1879, as follows: "It is wonderful that the old clumsy chemistry of raw beets is not universally abandoned. Hereafter instead of raw beets full of bitterness and with only 8 per cent of sugar, our mills will use dried beets, yielding 50 per cent of sugar. Instead of costing 7 cents a pound to make the sugar, half that sum will cover the cost. Instead of our mills working, at most, three and a half months of the year, they can be kept busy for twelve months. Instead of being dependent upon the vicissitudes of the weather for every year's crop, a supply can be held in stock for two years ahead. Baltimore may yet be destined to outrank New Orleans as a mart for sugar."

A correspondent of the Maryland Farmer, under date of March 19th, 1879, urges the advisability of growing sugar beets on the Eastern Shore and expresses the idea that it would be a great thing for all classes and that he intends trying them on an acre or more and hopes that he may be able to make a great deal of sugar for home use, using the refuse to fatten his cattle.

Mr. Andrew H. Ward, in the Maryland Farmer, for February, 1880, page 42, gives the cost of a sugar factory capable of working 30 tons of sugar beets per day. The total cost of the factory is given as $3,500. He estimates that such a factory would produce in a season 480,000 pounds of sugar! It is evident from the above that the days of rosy prophecy with dreams of immense pecuniary returns began early in the history of the sugar beet industry in this country.

The farmers in Harford county seem to have taken the most interest in the matter in September, 1880, when Mr. R. B. McCoy, together with other farmers of Harford county, reported experiments with the culture of the sugar beets. He stated that the chief difficulty encountered was getting the beets to the factory, the nearest one being at Wilmington, Del., and expressed the hope that a factory might be established at Havre de Grace. He stated that the soils in lower Harford county were fertile and capable of growing high grade beets.

With the failure of the factory in Wilmington, the interest in the sugar beet industry in Maryland seems to have completely died out. The next reference to the subject is in the Maryland Farmer for 1884, and this consists of statistics showing the enormous increase of the beet sugar industry in Europe and the consequent falling price of sugar. In the next month's issue, namely, October, 1884, the Farmer says: "The manufacture of beet sugar in this country so far has proven anything but a success. The chief cause of failure, according to manufacturers, is the unwillingness of farmers to grow beets in sufficient quantities. Only two beet sugar factories are at present in operation in North America, one in the Province of Quebec and the other in California." No further references to the culture of sugar beets in Maryland until recent years are found in the agriculture literature accessible.

In 1890, with the cooperation of the Chemical Division of the United States Department of Agriculture the Maryland Station grew quite a large quantity of sugar beets, with results which were quite favorable, in so far as regards the percentage of sugar. The data in relation to this work are found in the Third Annual Report of this Station, published in 1890, which is of such interest as to justify its insertion here.

"Two and one-half acres of land were cultivated in sugar beets during the season of 1890, for the Chemical Division of the United States Department of Agriculture. This was in connection with the general sugar investigation of the Department, and with special reference to the saccharine quality of the different varieties tried here, and the effect thereon of the various commercial manures applied.

"The land used was a portion of the sorghum field cultivated for the Department in 1889, and described on pages 148-49, in the Second Annual report of this Station. It was the central portion of that field which was selected for beets. The five varieties of beets were planted on long, narrow, half acre strips, running east and west, these were divided into twenty plots, running north and south, receiving as many different fertilizers or combinations of fertilizers. The latter were the same as applied to the same plots for sorghum, the year before, it being hoped that the special effects would be thus intensified. The five (5) varieties of beets were as follows: No. 1, Dippe's Vilmorin; No. 2, Simon Le Grand's White Improved; No. 3, Bulteau Desprez's Richest; No. 4, Florimond's Desprez Richest; No. 5, Dippe's Kleinwanzlebener. These were sown in rows 700 feet long and 2 feet apart.

"The soil was plowed and subsoiled, being thus worked at least a foot in depth, and repeatedly rolled and harrowed, until an excellent seed-bed was prepared. Seed was sown June the 7th, with a Planet Junior drill. A very heavy rain soon followed and packed the earth so hard as to greatly interfere with the vegetation, resulting in a poor 'stand.' Cultivation was thorough, with double wheel or push hoes and common hand tools. An attempt was made to improve the stand and make it more even, by transplanting, but the July drouth destroyed the plants thus moved. The crop was light and the size of the roots averaged rather small.

"All examinations of the beets were made at the Chemical Division of the Department of Agriculture, to which, under instructions received, sample roots were sent, every other day, from October 24th to December 2d. Every shipment represented all five varieties, as grown upon one fertilizer plot. At each shipment twenty or thirty average beets were pulled, and from these, two roots selected as fairly representing a variety; ten roots were thus sent, each time and delivered at the Department the day they were pulled.

"The results of the analyses were reported from the Department as fast as made. These roots properly belong to the Chemical portion of the report, but a summary is appended of the average results, and this shows the size and quality of the beets, of the different varieties.

TABLE VIII.—Size and Quality of Sugar Beets:

No.	Variety.	Weight of Beets: Averages in Ounces.	Average Per Cent of Sugar	Average Co-efficient of Purity.
1	Dippe's Vilmorin	11	13.4	83.6
2	Simon LeGrand's White Improved	10	13.0	81.0
3	Bulteau Desprez' Richest	11⅓	11.6	78.9
4	Florimond's Desprez' Richest	10⅓	10.8	76.2
5	Dippe's Kleinwanzlebener	8½	12.3	78.2
General Average		10¼	12.2	79.7
The best lot of beets averaged		23	20.9	94.7

"The results of the twenty different fertilizer plots, did not vary enough to make it worth extending the records.

"The general crop was harvested and stored by pitting, before any hard freezing weather. The five varieties were kept by themselves, but (under orders from Washington) no distinction made between roots of same variety grown with different fertilizers.* E. H. B."

The detailed results of the culture of the sugar beet in Maryland are found in Bulletin No. 30 of the Department of Agriculture, pages 15, 16 and 17. Eighty-one samples of beets were analyzed altogether, with the following results:

Mean weight of the beets	416 grams.
Mean content of sugar in the beets	12.3 per cent.
Purity	79.7.

The results above obtained are probably better than any others that have been secured in the State of Maryland on so large a scale. In a few instances the percentage of sugar in the beet was abnormally high, in one case 21 per cent. The beet in this case weighed only 90 grams. In a few instances, however, the percentage of sugar was very high, together with a fine weight of the beet, as, for instance, in one case where the percentage of sugar was 18.9, the weight was 375 grams and the purity 94.8.

In the Annual Report for the Maryland Agricultural Experiment Station for 1891, page 376, a short report is given on sugar beets. An attempt was made to grow an acre for stock feeding. The soil was a medium clay, well dressed with stable manure. Considerable difficulty was experienced in getting the seed to germinate. By transplanting, about one-fourth of an acre was secured. Evidently the difficulties experienced were far greater than in the previous year.

At the Department of Agriculture in 1891, only two samples of beets were received from Maryland. These were extremely poor, the average amount of sugar in the beet being 7.75 and the purity of the same only 68.5. The samples were both grown in Prince George's county, the mean weight of the beets being 16 ounces.

The reviving interest in beet culture was reflected also about this time in the Maryland Farmer, where a letter published in September, 1891, page 31, calls attention to the value of the large tracts of sandy, loamy soil in Maryland for the purpose of growing sugar beets. It was suggested that the State make an appropriation of thirty thousand dollars for a thorough trial of this industry.

The increase of the interest in Maryland, however, was very slight, since in the distribution of beet seed in 1893, by the Department of Agriculture, when 2,428 packages were sent out, only 13 were sent to Maryland.

In the Maryland Farmer for July, 1896, a subscriber asks if there is any record of the number of bushels of sugar beets, raised to the acre in the State of Maryland. Gen. Geo. S. Brown, of Baltimore, it is stated, raised on a quarter of an acre of his farm, a number of years ago, 223 bushels, equal to 892 bushels to the acre:

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* Note: Since this report was prepared. the Chemist of the Department has found the sugar beets raised at this Station of such an exceptionally high quality, as compared with those grown in other parts of the country. that he has ordered all the roots remaining here to be sent to the Government Beet Sugar Station in Nebraska, to be there used for producing seed in 1891; a composite sample of the soil from our beet-field has also been asked for by the Chemist of the Nebraska Station. This seems to justify making this record, and also further efforts in growing sugar beets upon the farm of the Maryland Agricultural College. H. E. A.

In 1897, 29 samples of beets grown in Maryland were analyzed in the Division of Chemistry, of the Department of Agriculture. These beets were from the following counties:

Anne Arundel	4
Baltimore	3
Frederick	2
Harford	4
Montgomery	4
Prince George	3
Talbot	3
Washington	5
Wiconico	1
Total	29

The mean results of the analyses were as follows:

Mean weight	19 ounces
Mean per cent of sugar in the beet	11.41 per cent.
Mean purity coefficient	79.1

"All the analyses of the samples of beets* grown in Maryland were made in the laboratory of this Division, the Agricultural Station at College Park, not having undertaken any work of this kind. The whole number of samples received from the State was 29. The mean size of the beets was 19 ounces, the mean percentage of sugar in the beets 11.4, and the mean purity of the juices 79.1. In respect of size, the samples from Maryland are about the mean. The purity of the juice is almost up to the minimum standard, but the percentage of sugar in the beet is about 0.6 less than is advisable for manufacture.

"In regard to climatic conditions, as has before intimated, the State of Maryland occupies a somewhat peculiar position. There is a considerable area along the Eastern Shore, next to the ocean, where the average summer temperature is 71 degrees. In the western part of the State, after a long deflection to the north, the isotherm of 71 degrees may again be found. Lying immediately south of the isotherm of 71 degrees, in the northern portion of Maryland, are found some very fine valley lands, where the conditions of culture may be considered favorable. These lands are underlaid by limestone, which, in many cases, comes to the surface. Theoretically, they are a little too warm for the most successful culture, but lying so near the favorable thermal belt there may be reasonable hopes of successful culture in many localities. In the western portion of the State, where the thermal conditions are favorable, we find the mountain ranges, and the low temperature of the summer is due to the high elevation. The quantity of table lands upon the tops of the mountains, however, is not sufficiently great to warrant the expectation of the founding of a great industry, but there is no doubt of the possibility of growing very rich beets on these table lands. In general, it may be said, that the State of Maryland is not very favorably situated for the culture of sugar beets, but there are circumscribed localities within the State where it is desirable to conduct further experiments. It is, therefore, earnestly hoped that the Agricultural Experiment Station of the State will make a more careful agricultural survey of the possibilities of the culture of sugar beets therein."*

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*Refers to samples in preceding table.

During the season of 1898 a number of experiments in the growth of sugar beets in Maryland, was conducted, under the joint auspices of the Maryland Agricultural Experiment Station and the Department of Agriculture. Thirty-one samples of beets were received for analysis, grown in different parts of the State. The average weight of the samples was 22 ounces, the mean content of sugar 10.4 per cent and the mean purity 76. The following table gives the names and locations of the growers of the samples, together with a detailed analysis of each sample:

The best sample was grown by Charles D. Reaves, of Baltimore. His samples showed the highest sugar content and the highest purity. Other samples showing a high sugar content were grown by L. Hegmaier, of Cumberland, and Horace Venables, of Mardella Springs. The average excellence of the beets was not quite equal to that of some other years, but the average size was entirely satisfactory.

The highest content of sugar in any one sample was 15.7 per cent, and the highest purity coefficient was 85.7.

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*Bulletin No. 52, Division of Chemistry, Department of Agriculture, Pages 77-78.

REPORT OF SUGAR BEETS GROWN IN MARYLAND, 1898.

Name.	Locality.	Average Weight.	Sugar Per Cent.	Coefficient of Purity.
Chas. F. Welenourky..	Tannery..........	29 ozs.	.8	74.1
Edwin J. Derickson ...	Berlin............	28 "	8 8	80.2
Geo. S. Willison	Cumberland.....	23 "	12.3	80.1
J. B. W. Gardiner......	Bryantown.......	36 "	10.0	74.0
John T. Rutter.........	Woodlawn,.......	29 "	10.7	78.5
U. M. Stanton..........	Grantsville......	23 "	13.1	83.6
N. H. Fooks............	Preston...........	32 "	9.1	75.0
L. Hegmaier...........	Cumberland.	46 "	10.6	74.7
L. Hegmaier...........	Cumberland.	23 "	13.8	81.0
Edw. F. Tucker...	Araby...	23 "	6.6	66.7
W. S. Davis............	Clements	14 "	8.4	71.0
Horace Venables......	Mardella Springs	13 "	13.9	78.5
Geo. H. Payne..........	Compton.........	9 "	10.7	71.1
H. J. Mitchell	Pocomoke City ..	20 "	8.6	75.0
J. B. W. Gardiner	Bryantown.	25 "	9.5	73.5
John T. Best............	Frederick........	28 "	10 5	75.2
Chas. C. Webster.......	Thurmont........	30 "	9.7	75.0
Chas. C. Webster	Thurmont........	22 "	9.1	72.6
W. T. Stanton..........	Grantsville	19 "	12.3	77.7
John T. Best............	Frederick........	16 "	9.7	76.1
Walter Williams........	Poolesville.......	7 "	10.6	
Rev. R. H. Murphy.....	Port Republic....	16 "	10.9	81.3
T. Benton Daugherty...	Dublin, ...	17 "	8.8	72.7
Henry Strite............	Hagerstown......	27 "	9.6	70.1
Charles D Reaves......	Baltimore........	16 "	14.2	84.7
Charles D. Reaves......	Baltimore........	13 "	13.6	83.1
Wm. A. Smith..........	Woodwardsville..	27 "	7.2	72.4
N. D. S. Parray.........	St Leonard's.....	11 "	8.1	74.6
Alex. Bowling..........	Bryantown.	13 "	11.9	81.7
Alex. Bowling..........	Bryantown..... .	11 "	10.9	77.2
D. C. Kemp.............	Frederick........	23 "	10.4	69.0
Total No. of Samples 31	Means	22	10.4	76.0
	Maxima	46	14.2	84.7
	Minima	7	6.6	66.7

ADAPTABILITY OF THE SOIL AND CLIMATE OF MARYLAND TO SUGAR BEET CULTURE.

In the résumé, which has been given above of an historical nature, showing what has been accomplished with sugar beets in Maryland, it will be noticed that the actual analytical data are few in number and that most of the interest which has been manifested in Maryland has been in the discussion of the problem rather than in its elucidation. A few additional words, therefore, are necessary in regard to the adaptability of the soil and climate of Maryland to the raising of sugar beets and a comparison of the possibilities of successful beet culture there with some of the other portions of the country.

It has been established by very extensive investigation and experiment, in this country, that the southern limit of sugar beet culture, where particularly high grades of beets are desired, is practically the isotherm of 71 degrees F., mean temperature for the summer months of June, July and August. This isotherm touches the State of Maryland in two places, first, on the coast line on the Eastern Shore, passing in an almost due north and south direction, and after making a long detour to the north, reaching almost to Albany, this isotherm turns in a southwestern direction and enters the State of Maryland again in the extreme western portion, coming into the State from Pennsylvania at a point on the border almost northwest of Williamsport. It is thus seen that the limits of most favorable temperature, exclude the greater part of the State from the area most suitable for beet culture. The data which have already been secured, show that beets of fair average quality can be grown in all parts of the State of Maryland, and a few instances have been cited where the beets produced were of exceptionally fine quality. It is evident, however, that upon the whole the climate of Maryland is too warm during the time specified to produce beets of the highest grade.

The character of the climate of the Eastern Shore, immediately adjoining the Atlantic Ocean, presents fairly favorable conditions, but that area is too small to warrant the assumption that a large industry could be established.

In Bulletin No. 52, (Revised) of the Division of Chemistry, the following statements are made on pages 27 and 28:

"EASTERN SHORE OF MARYLAND."

"The isotherm of 71 degrees enters Maryland at a point about the centre of the Atlantic Coast of the Eastern Shore, and runs north by northeast almost to Poughkeepsie, N. Y. It is evident, therefore, that the temperature conditions of this region are similar to those on or south of the isotherm of 71 degrees in other parts of the country, although here in this area the region lies to the west of this isotherm. Judged by this factor, and also by the mean annual rainfall, which is 40 inches for this locality, the cultivation of the sugar beet might be successfully inaugurated along the Atlantic Coast of the Eastern Shore; in fact, practically over the whole of the southern portion of the Eastern Shore of Maryland. The character of the soil in this locality is mostly sandy, and its natural fertility has been considerably diminished by long years of cultivation. There is no reason to doubt, however, the fact that with proper fertilization and cultivation the requisite degree of fertility for the production of sugar beets could be secured. The general tendency in this region is in the direction of a too high temperature and too few hours of sunshine. The above observations apply also to Accomac county, Va."

In the northwestern part of the State, where the thermal conditions are also favorable, the result has been brought about by the high elevation of the Allegheny Mountains. The contour of the land in this portion of the State, hilly and mountainous, is unfavorable to beet culture, and it is only on the high table lands of the mountainous regions that any adequate areas for beet culture can be secured. These are limited in extent, and, therefore, any expectation of establishing any considerable sugar beet industry in this locality must be abandoned.

The causes which produce these unfavorable conditions in Maryland are twofold. In the first place the southern latitude secures shorter summer days than obtain farther north. The mean length of the summer days, i. e., the hours of sunshine, excluding all clouds and fogs at Baltimore, Md.; Bay City, Mich.; Lille, France, and Madgeburg, Germany, is shown in the following table:

	Degrees	June	July	August
Baltimore, Md................	39 North	14.9 Hours	14.6 Hours	13.7 Hours
Bay City, Mich..............	44	15.4 "	15.1 "	14.0 "
Lille, France.................	51	16.5 "	16.0 "	14.5 "
Madgeburg, Ger.............	52	16.7 "	16.2 "	14.6 "

AVERAGE DAILY DURATION OF POSSIBLE SUNSHINE.

It is thus seen that the beet fields in the vicinity of Bay City, Mich., have nearly a half hour more sunshine than those in the vicinity of Baltimore, Md., while at Magdeburg the mean duration of sunshine is nearly an hour and a half greater than at Baltimore for the periods mentioned. Since the production of sugar is solely a function of the leaves under the influence of the sunlight, and the proper temperature, it is evident that the capacity for making and storing sugar in the beets grown near Bay City, is greater by far than that of the beets grown in the vicinity of Baltimore. Thus the thermal conditions not only act adversely by causing too high a temperature, for the most favorable storing of sugar, but in this country also act unfavorably by shortening the hours of sunlight, thereby restricting the activity of the cells of the leaves. If the temperature in the vicinity of Baltimore were exactly the same as that in the vicinity of Bay City, there would still be a distinct advantage secured by growing beets in the more northern locality. One of the chief reasons of the great success of the beet culture in the north of France and in Germany, is the great length of the days in these northern latitudes as well as the more equable distribution of temperature. The mean length of the summer days at Lille, France, is 15.67 hours, and at Madgeburg, the centre of the beet sugar industry in Germany, 15.83 hours. It is thus seen that there is a distinct advantage derived from an abundance of sunlight in the more northern localities.

Another point to be noticed is that the intense heat of the summer days in Maryland tends to harden the ground and to raise the temperature of the upper parts of the beets, to a degree incompatible with the maximum storage of sugar. The hot days also tend to ripen the crop prematurely,so that the dangers which come from a second growth due to autumnal rains, are greatly increased. A beet which has not quite matured by the latter part of September is not greatly injured by the heavy autumnal rains, which are usual at that season. On the other hand, if the beet be perfectly matured, an entirely new growth of the leaf system is established and this growth is largely at the expense of the sugar which has been stored. In this fact is found another reason unfavorable to the growth of beets in Maryland.

SOIL.

In regard to the soil of Maryland, little need be said. There are many areas of large extent where the soil is favorable to the growth of beets. The ideal soil is one which contains a sufficient amount of sand to prevent it becoming hard in summer, and yet has not enough to diminish the fertility of the soil. Such a sandy soil with a fair proportion of organic matter, and with a reasonably abundant supply of mineral plant foods, affords the best environment, in so far as the soil conditions are concerned, in beet development. The impermeable subsoil should not be too close to the surface, but at least from 18 to 20 inches below. The tap roots of the beets should meet with no very great obstruction within 18 or 20 inches of the surface. This enables them to grow straight down and to develop symmetrically, thus securing the maximum storage of sugar. There are many localities in Maryland where the limestone strata come to the surface, and where the depth of the soil overlying the limestone is not very great. It is evident that such a soil, although reasonably fertile, would not be suitable to beet culture, because of its lack of depth. There are also many very sandy soils devoted largely to the growth of market garden crops, which are not so well suited to beet growth, although the beet will stand a very large percentage of sand, if it be properly fertilized. Even these excessively sandy soils, therefore, will grow excellent beets, provided the crops are fed the proper quantities of mineral and organic foods in the fertilizers employed.

From a careful study of all the accessible data, taking into consideration the soil and climatic conditions, it is evident that no very favorable environment exists in the greater part of Maryland for beet culture. Where the soil conditions are favorable, beets can be grown having a sugar content of about 12 per cent. It is evident that beets of this quality would give an abundant yield of sugar, and if we were speaking of the conditions a quarter of a century ago, such beets could be grown and manufactured into sugar with the greatest profit.

On the other hand, it must be remembered that there are many places in the United States of wide extent, where, with the same attention, beets can be grown with an average content of nearly 15 per cent of sugar. Many such localities are found in northern New York, Michigan and Wisconsin, and many of a like character are found in the West along the Pacific Coast. It does not, therefore, seem the part of wisdom to attempt to establish a beet sugar industry in Maryland, where the product obtained would have to come in competition with that from the more favorable localities, to which attention has been called.

METHODS OF CULTIVATION.

It has been suggested that it might prove very profitable for Maryland farmers, especially those engaged in the dairy industry, to grow sugar beets for cattle food. The sugar beet has a distinct advantage over rutabaga, turnip or other common root crops, grown for feeding domestic animals, in having a much higher percentage of sugar and thus a greater fattening power. Sugar beets as a cattle food have proved to be very advantageous for dairy cattle, provided the roots are not fed in sufficient quantities to induce the formation of an excessive amount of fat. The yield, per acre, of the sugar beet, is not so great as any of the other root crops mentioned, but the actual amount of food material produced in a crop of ten tons of sugar beets is almost as great as in a crop of twenty tons of rutabaga or in thirty tons of turnips. There is, therefore, some economy gained by handling a crop smaller in amount, but possessing a higher concentration of food qualities. The high value of sugar beets as a cattle food might justly warrant a suitable degree of at least experimental culture for the purpose mentioned.

SELECTION OF SOIL.

In selecting the soil for the growth of sugar beets, even if raised for cattle feeding purposes, a sandy, loamy soil should be preferred. The soil should contain enough sand to prevent its baking after hard rains in the summer, and at the same time a sufficient quantity of organic matter and mineral plant food to nourish the crop. The sugar beet is a high feeder, and requires a much larger quantity of plant food, per acre, than a cereal crop. A soil above the average in fertility is therefore desirable for sugar beet purposes.

The contour of the soil should be reasonably level, since the culture of beets is not easily accomplished on hillsides or on rough ground.

The soil should have a reasonable depth and at least two feet or two and a half feet should intervene between the surface and any impenetrable medium, such as rock, hard impervious clay or gravel. For a like reason the permanent water line of the soil should not be too near the surface, since the presence of water would cause the tap root to rot and thus destroy the chief source of supply of the growing plant.

PREPARATION OF THE SOIL.

For the proper growth of sugar beets it is best that the field be ployed to a depth of eight or ten inches, and the subsoil to a depth of six inches more, in the autumn previous to the planting. Late November or early December, according to the severity of the weather, is a favorable time for the preparation of the soil. If the soil be plowed at an earlier date some catch crop, such as rye, should be sown, in order to protect the surface of the soil and to avoid the loss of nitrogen until the full advent of winter. In the spring, in case the catch crop has been sown, it should be plowed under to the depth of about three or four inches, at the earliest possible moment and the surface of the soil reduced to the proper tilth by harrows, cultivators or disk-harrows. It is highly important that the seed bed be in the best possible condition before planting.

FERTILIZATION.

Nearly all soils, especially those which have been under cultivation for a long time, require generous fertilization in order to produce a paying crop of beets. Barnyard manure should be avoided, or if applied at all should be applied the previous year in an almost rotten state. Mineral fertilizers can be applied in the spring and worked deeply into the soil by the time set for cultivation. From three to five hundred pounds of acid phosphate and from two to three hundred pounds of potash per acre can be profitably added. The nitrogeneous fertilizer may consist of the nitrate of soda, which, however, should not be in a greater quantity than from one hundred to two hundred pounds per acre. Nitrate of soda offers the immediate nitrogen necessary for the young crop. Later, nitrogen for the completion of the growth and the maturity of the crop can be supplied in the form of tankage,cottonseed meal or other similar nitrogeneous fertilizer, at the rate of from two to three hundred pounds per acre.

PLANTING.

The planting should be done as early as possible in the season. In Maryland the planting can even be accomplished in April, and the sooner the better. About twenty pounds of seed should be used per acre, and these are best planted by means of a drill in rows from eighteen to twenty inches apart. The seed should be covered lightly, not exceeding three-quarters of an inch in depth and less if the surface be moist and in good condition. The germs of the beet seeds are extremely tender and reach the surface with difficulty if too much earth be placed over them.

CULTIVATION.

Level cultivation should be practiced, the surface being kept well pulverized and free from weeds. The hoe is a very useful instrument in early cultivation.

THINNING.

When the young beets begin to show four leaves, they should be thinned, leaving from six to nine inches between the plants in the rows, according to the fertility of the soil. Since often two or three sprouts come from the same seed, great care should be exercised in removing the extra plants, so as not to remove the whole bunch from the soil. When the leaves of the beet fully cover the surface of the soil, about the middle or end of July, the cultivation may be suspended.

HARVESTING.

The beets are best harvested by passing the lifter underneath the roots, which breaks the tap roots and loosens the beets in position. The beets are then removed by hand, by means of the leaves. The leaves may be removed and make an excellent cattle food.

SILOING.

When beets are to be kept for winter use they are placed in silos, after the removal of the leaves, and protected in the same manner as potatoes, turnips or other root crops under similar conditions.

FEEDING.

For feeding purposes, the beets should be washed to remove the dirt and, to aid mastication, should be cut into pieces of convenient size.

Full details in regard to planting and cultivating beets and a description of the agricultural implements used are found in Revised Farmers' Bulletin No. 52, which can be had free of charge by application to the Secretary of Agriculture, at Washington, D. C.

THE SUGAR BEET IN MARYLAND.

Conclusions:

1. The sugar beet has been cultivated in Maryland with more or less regularity since the year 1874. In 1879 and '80 a great interest in the sugar beet industry was manifested in the State and attempts were made to establish factories, but without success. At that time it was the general opinion among the agricultural papers and farmers of Maryland that the soil and climate of the State were as well adapted to the growth of sugar beets as any of the areas of Europe.

2. With the reviving interest in the industry in 1890 and '91 the Maryland Agricultural Experiment Station collaborated with the Department of Agriculture in the growth of the usual varieties of beets. It was proved that beets of fairly good size and content of sugar could

be grown in the State. The average content of sugar secured in these experiments was a little over 12 per cent, with a purity of a little less than 80. The yield per acre, however, was low and many of the beets were too small for profitable handling.

3. The possibility of the successful culture of the sugar beet in Maryland as a cattle food, is worth a practical demonstration. The sugar beet is a much richer cattle food, ton for ton, than any other common root crop and while the yield per acre is less, the available nutritive material is quite as great.

4. There are many areas in Maryland where the soil, both in its composition and contour is favorable to beet culture, and where, by reason of location, the freight on fertilizers would be low. It is probable if the soil conditions alone were to be considered, that Maryland could successfully compete with other States of the Union in the growth of sugar beets.

5. The climatic conditions of Maryland are distinctly unfavorable to the growth of beets of maximum sugar content and purity. The mean temperature for the months of June, July and August is too high to secure the best results and the mean hours of sunshine for those months are too short. The most favorable climatic conditions for beet culture are secured in high northern latitudes, where summer days are long. The northern limit for the growth of sugar beets is determined only by the shortness of the season preventing maturity. The hot and dry days of the Maryland summers hasten the beets to premature maturity and thus increase the dangers arising from a second growth in the period following the autumnal rains.

6. In the present state of the sugar industry it has been established that Maryland cannot successfully compete in the manufacture of beet sugar with more favorable localities of the United States.

THE MARYLAND
AGRICULTURAL EXPERIMENT STATION

BULLETIN No. 62. JUNE, 1899.

Variety and Culture Experiments with Wheat, Corn and Potatoes.

Variety Tests of Wheat—1898.

The general plan of the variety test with wheat in 1898 was the same as reported in Bulletin No. 56, and in the main was a continuation of the work which had been in progress for a number of years. The varieties used in the test were those which were considered standard and the most promising grown in former years, together with such new varieties of late introduction as came to our notice, or upon which favorable reports had been received from various sections of this State.

The land used for this test was in corn in 1896, in which crimson clover was seeded at the last working, the latter part of July. The crimson clover came up well and gave a good covering to the land during the winter and the following spring made a very fine growth and would have cut about two tons of hay per acre. This crimson clover was allowed to mature and the plant began to die, and then (in June) it was plowed under as a preparation for the wheat, to be sown in the fall. The land was harrowed from time to time during the summer to keep it free of grass and after it was gotten into thorough order with harrows and rubber the wheat was seeded October 1st, 1897, at the rate of six pecks per acre. Commercial fertilizer was applied at the rate of 400 pounds per acre, with the drill at the time of seeding the wheat. The fertilizer used was a home mixture composed of:

Dissolved South Carolina rock..........	1,200	pounds
Bone tankage........................	400	"
Nitrate of Soda......................	100	"
Muriate of Potash....................	300	"
Total	2,000	"

The experiments recorded in this Bulletin were planned by Robert H. Miller, Ex-Director of the Station. and the details were carried out and the records kept under the supervision of Ernest H. Brinkley. Ex-Assistant Agriculturist. Assistant Agriculturist E. O. Garner has aided in the compilation of the results. but for the plan of making the report and the general discussion of the results I am personally responsible.

H. J. PATTERSON, Director.

This mixture cost about twenty dollars per ton and had approximately the following composition:

Phosphoric acid	9	per cent
Nitrogen	2	"
Potash	7½	"

It should be noticed that the nitrogen in this fertilizer was furnished in two forms, viz.: Mineral nitrogen by the nitrate of soda, which is very readily available and serves to give the crop a good start in the fall and have strong healthy plants, which have stooled out well, to go through the winter; and the organic nitrogen which is furnished by the tankage and which becomes available gradually, and this, together with the nitrogen furnished by the decomposing clover will meet the needs of the crop from spring until maturity. This method of nitrogenous fertilization will be found quite essential for all fall grains, and particularly so on land void of organic matter and in a poor state of fertility, as it is necessary to get a good strong plant well stooled out in the fall if a good crop is to be expected. Fall seeded grains stool little, if any, in the spring.

A list of the varieties tested, together with their principal characteristics and yields are given in Table 1.

The promise in the early spring and up to about the middle of May was for exceptionally large yields, but an examination of the yields in the table will show that they average lower than those obtained during the past few years. This is attributed in the most part to the weather turning suddenly, very hot and dry, which caused premature ripening, and in consequence, shrivelled grain. This opinion is also borne out by the fact that as a rule the earlier varieties suffered the least.

The six varieties giving the highest yields were as follows: Lebanon, 35.4 bushels; Currell's Prolific, 35.3 bushels; Dietz, 34.5 bushels; Russell, 32.9 bushels; Pool, 31.8 bushels, and Fultz, 31.8 bushels, which in the main are the varieties which have been doing well for a number of years past.

TABLE I.—YIELD PER ACRE AND CHARACTERISTICS OF VARIETES OF WHEAT TESTED IN 1898. SIZE OF PLOTS, 3412 SQUARE FEET.

Plot No. Varieties.	Yield per Acre. Bushels.	Color of Grain.	Head.	Straw.
1 Ex. Early Oakley	26.6	Amber	Smooth	Stiff
2 Pool	31.8	Red	Smooth	Fairly Stiff
3 Currell's Prolific	35.3	Red	Smooth	Stiff
4 Badger	28.6	Red	Smooth	Stiff
5 Fultz	31.8	Red	Smooth	Stiff
6 Ontario's Wonder	29.5	Red	Smooth	Stiff
7 Rocky Mountain.	27.4	Red	Smooth	Stiff
8 Wyandott Red	29.1	Red	Smooth	Stiff
9 Finley	29.7	Red	Smooth	Fairly Stiff
10 Fultz	24.4	Red	Smooth	Stiff
11 Wis. Triumph	27.5	Amber	Smooth	Stiff
12 Garfield	25.9	Red	Smooth	Stiff
13 Terry	27.6	Red	Smooth	Stiff
14 Russell	32.9	Red	Smooth	Stiff
15 Fultz	22.0	Red	Smooth	Stiff
16 Jone's Sq. Head.	19.3	White	Smooth	Stiff
17 Valley	29.0	Red	Bearded	Stiff
18 Ruby	24.7	Red	Bearded	Stiff
19 Dietz	34.5	Red	Bearded	Fairly Stiff
20 Fultz	23.8	Red	Smooth	Stiff
21 Lehigh	26.0	Red	Bearded	Fairly Stiff
22 Lebanon	35.4	Red	Bearded	Weak
23 Tuscan Island	26.9	Red	Bearded	Stiff
24 Beal	11.9	Amber	Bearded	Stiff
25 Fultz	25.1	Red	Smooth	Stiff
26 Nigger	30.8	Red	Bearded	Stiff
27 Egyptian	31.5	Red	Bearded	Stiff
28 Gold Coin	20.8	Amber	Smooth	Stiff
29 ussian	14.6	Red	Bearded	Stiff
30 Fultz	25.3	Red	Smooth	Stiff
Average of six Fultz plots	25.4			

On the following pages will be found a list of all the varieties of wheat tested at this Station, up to the present time, classified according to their principal characteristics. There is also given the figures showing the maximum, minimum and average yields obtained with the different varieties. It will be noticed that the minimum yields in most cases are very low. The most of these low yields were obtained in the earlier years of the tests, when the land at this place was in a very run down condition and entirely unfit for the cultivation, not only of wheat, but all classes of crops. Yet, it is interesting to note the changes that can be brought about in a few years, and this, too, by methods within the reach of all Maryland farmers. The land at the Experiment Station ten years ago was unproductive, chiefly because of its physical condition, which was in the main due to being wet and void of organic matter. The first step in producing the proper physical condition was to drain the wet portions by both tiling or open ditches. After this was done the main factors in bringing the land to a satisfactory physical condition for cultivation was to grow green crops, such as cow peas and crimson clover, for turning under, and applying small quantities of lime (20 bushels per acre). In addition to this treatment, the crops were manured with commercial fertilizer, which was particularly rich in phosphoric acid and potash, as will be seen on reference to Wheat bulletins Nos. 10, 14, 28, 35 and 56.

In the tests of varieties new ones were added from time to time and the unpromising ones were discarded, so that comparatively few were grown continuously through any number of years. Of the twenty varieties which were under test over six years, fourteen gave average yields of over thirty bushels per acre, which stand in the following order:

		Bushels.			Bushels.
1	Fultz	36.1	8	Badger	31.9
2	Lebanon	35.5	9	Garfield	31.6
3	Egyptian	34.3	10	Dietz	31.4
4	Wisconsin Triumph	33.8	11	Extra Early Oakley	31.1
5	Tuscan Island	33.5	12	Jones' Square Head	30.9
6	Currell's Prolific	32.6	13	Finley	32.5
7	Beal	32.5	14	Lehigh	30.0

From these results it will appear that the hunt for a superior new variety of wheat for Maryland farmers to adopt as their standard was in a measure fruitless, as the variety which heads our list, and which, under ordinary circumstances, we would recommend to the average Maryland farmer for the crop variety is the stand-by today and was so twenty years ago. While, as the above figures show, there are a number of good varieties of wheat and no doubt that some will be adapted to particular soils and locations, better than the Fultz, yet, none of them are likely to meet the requirements over so great a range of territory and so long a period of time as it has done.

Where Fultz has once done well and now fails to give satisfactory yields, it will generally be found to be due to a deterioration of the seed, either from lack of care in selection or in becoming very much mixed with other varieties. With proper care in observation and selection, it is just as rational and possible to breed up a variety of grain adapted to a particular soil and location as it is to breed up a dairy herd for milk or butter production or hens for egg production. This is a side of farming that is rarely given consideration by a farmer, and yet should be very fruitful of results. Experiments have shown that getting seed wheat from different localities did not give increased yields, but rather with care in selection of seed, that the yield improved with becoming acclimated.

Taking these facts into consideration, the variety tests on the plan pursued in the past will be discontinued and instead experiments will be conducted on selections and breeding up of seed wheats. This work has already been entered upon. Another lesson that may be learned from the work done here is that it is perfectly possible with proper cultivation on lands adapted to growing wheat to make the average yield 30 or more bushels per acre, and seldom, if ever, to fall below 25 bushels. In fact, unless a yield of at least 30 bushels can be obtained, it is doubtful if a farmer is ever justified in growing a crop of wheat, for at present prices, a less yield will cost more than it returns. Even the idea of growing wheat as a necessary step in setting the lands to grass or hay crops, or of growing wheat for the straw for bedding is not a justifiable excuse, as grass can better set when by itself and bedding can be gotten in greater abundance cheaper and of better quality by growing corn and shredding the fodder:

TABLE II.—LIST OF VARIETIES OF WHEAT TESTED AT THE MARYLAND AGRICULTURAL STATION FROM 1889 TO 1899.

	Name of Variety.	No of Years Grown.	Maximum Yield.	Minimum Yield.	Avr'ge Yield.
	White Smooth Wheats:				
1	Golden Amber	3	32.7	7.5	20.5
2	Jones' Square Head........	6	40.0	19.3	30.9
3	Miller's Prolific............	3	20.9	10.6	15.1
4	New Australian	4	38.9	10.2	24.6
5	White Leader..............	1	....	....	21.2
6	White Track	2	9.1	7.6	8.4
	White-Bearded Wheats:				
7	Genesee Giant	1	....	....	27.8
	Amber Smooth Wheats:				
8	Extra Early Oakley........	7	42.4	17.9	31.2
9	Gold Coin	1	....	....	20.8
10	Imperial Rice	3	26.8	10.1	17.0
11	Martin's Amber	3	35.3	13.2	21.2
12	McCregan	1	....	....	11.8
13	Wisconsin Triumph	6	49.6	11.9	33.8
	Amber-Bearded Wheats:				
14	Beal	7	47.9	14.5	32.5
	Red Smooth Wheats:				
15	American Bronze	1	....	....	7.3
16	Arnold's Hybrid		....	....	17.7
17	Badger	7	46.7	9.3	31.9
18	Buckeye	3	31.8	11.5	22.3
19	Currell's Prolific...........	8	45.5	13.6	32.6
20	Early Ripe.................	1	....	....	17.8
21	Finley	8	40.2	12.7	30.8
22	Fultz	7	47.1	22.1	36.1
23	Garfield	7	42.5	10.3	31.6
24	German Emperor..........	2	32.7	28.2	35.4
25	Golden Drop	1	....	....	8.9
26	Hickman	2	36.6	30.3	33.4
27	High Grade	2	19.3	12.2	15.7
28	Hybridized Fultz	2	12.6	7.2	9.9

	Name of Variety.	No. of Years Grown.	Maximum Yield.	Minimum Yield.	Avr'ge Yield.
29	Jones' Winter Fife	1	....	....	10.6
30	McGhee's Red	2	25.1	25.1	25.1
31	Mealey	4	39.9	11.3	23.5
32	New Early Red Clawson	3	32.1	3.7	14.0
33	New Monarch	2	10.0	8.7	9.3
34	Ontario	8	39.7	4.6	26.4
35	Oregon	1	....	....	34.2
36	Pool	7	39.1	9.9	28.0
37	Red Fultz	1	....	....	11.7
38	Red May	1	....	....	19.7
39	Red Russian	3	38.9	9.7	25.2
40	Rochester Red	1	....	....	9.3
41	Rocky Mountain	5	41.8	27.4	33.7
42	Russell	3	38.9	31.8	34.5
43	Strayer's Romania	2	13.9	12.5	13.2
44	Terry	3	37.7	27.6	34.2
45	Winter Fife	2	41.0	31.8	36.4
46	Wyandott Red	8	41.0	12.7	29.9
47	Zimmerman	1	....	....	17.2
	Red-Bearded Wheats:				
48	Diehl's Mediterranean	4	32.5	12.0	22.7
49	Dietz	8	42.0	10.5	31.4
50	Dietz Longberry	2	25.9	7.8	16.8
51	Egyptian	6	39.2	28.0	34.3
52	Fulcaster	2	16.5	16.3	16.4
53	Fultz Blue Stem	2	29.3	29.0	29.2
54	Golden Cross	2	10.4	6.5	8.4
55	Hindoostan	2	3.1	2.9	3.0
56	Hungarian	2	14.5	10.1	12.3
57	Hybrid Dattle	1	....	....	4.6
58	Hybrid Larned	1	....	....	4.2
59	Kentucky Giant	1	....	....	25.0
60	Lebanon	6	42.2	30.2	35.5
61	Lehigh	7	37.0	11.8	30.0
62	Mediterranean	1	....	....	24.9
63	Mediterranean Hybrid	2	8.7	7.6	8.1
64	Miami Valley	2	39.0	32.3	35.6
65	Nigger	8	39.0	6.5	26.4
66	Pegnette's Velvet Chaff	2	14.4	11.1	12.7
67	Raub's Black Prolific	1	....	....	25.9
68	Red Wabash	2	30.5	29.3	29.9
69	Red Wonder	1	....	....	28.1
70	Reliable	2	8.7	8.2	8.4
71	Ruby	4	41.0	24.7	29.8
72	Russian	1	....	....	14.6
73	Seneca Chief	2	9.4	8.0	8.7
74	Strayer's Egyptian	2	16.3	15.4	15.8
75	Strayer's Longberry	2	12.9	11.7	12.3
76	Tasmania Red	1	....	....	12.8
77	Thesis	2	36.2	25.5	30.8
78	Tuscan Island	7	42.4	16.6	33.5
79	Valley	8	42.9	6.7	29.8
80	Velvet Chaff	4	33.8	11.5	20.4

CORN EXPERIMENTS IN 1897 AND 1898.

The experiments made with corn during the seasons of 1897 and 1898 consisted of culture and working tests, and were a continuation of those which were inaugurated in 1893, and upon which reports have been made in Bulletins Nos. 25, 33 and 46. These tests my be classified as follows:

1. Deep vs. Shallow Cultivation.
2. Frequent vs. Unfrequent Cultivation.
3. Wide vs. Narrow Rows.
4. Planting in Drills vs. Checking.

Land used:—The land used for these tests in 1897 had been in early potatoes in 1896, and after digging the potatoes, the land was seeded to crimson clover. The clover took well and made a good growth during the fall which completely covered the ground during the winter. The clover was plowed under the 19th of May, 1897, at which time the heads were beginning to die. The land was thoroughly prepared by means of rubber and harrows and planted to corn May 28th to 31st. All the plots except that for unfrequent cultivation were cultivated three times, June 21st, July 3rd and July 17th. The unfrequent plot received no cultivation on July 3rd.

The land used in 1898 was a sod, from which crops of hay had been cut two years in succession. The sod was plowed down January 20th, which was allowed to lay until April 9th, when it was prepared by means of a "Cutaway" harrow, followed by the rubber and spring toothed harrow. Each test was performed in duplicate on alternate plots, so as to overcome any unevenness in the land.

The corn was planted May 4th, and all the plots were cultivated on May 28th, June 17th and July 11th, except the unfrequent cultivation plot, which received no working on June 11th. All the plots were seeded to crimson clover on July 23rd. Corn was cut on September 13th and husked October 26th to 28th. The spacing of rows and hills and the quantity of corn to each hill was the same as used in these tests in previous years, which was as follows:

On plots of Frequent Cultivation, Unfrequent Cultivation, Deep Cultivation and Shallow Cultivation the rows were 3 feet 9 inches apart and the corn planted 15 inches apart in the row, one grain to each hill. On the checked row plot the hills were 3 feet 9 inches by 3 feet 9 inches and two grains to the hill, while with the drilled corn the rows were 3 feet 9 inches apart and one grain planted every 22½ inches in the row. On the wide row plots the rows were 5 feet apart and one stalk to each 12 inches of the rows, while in the Narrow Rows the distance apart was 3 feet 9 inches and the stalk 15 inches apart in the rows. There was no fertilizer of any kind applied to the land for these tests in 1897 and 1898. In the following tables are given the results of the tests enumerated above, together with those obtained in previous years during which these tests were conducted and averages of the same.

DEEP VERSUS SHALLOW CULTIVATION OF CORN.

TABLE III.—YIELD OF CORN AND FODDER PER ACRE.
FOR SIX CONSECUTIVE YEARS.

Years Tested.	Deep Cultivation.				Shallow Cultivation			
	Merchantable Grain. Bus.	Unmerchantable Grain. Bus.	Total Yield of Grain. Bus.	Fodder lbs.	Merchantable Grain. Bus.	Unmerchantable Grain. Bus.	Total Yield. of Grain. Bus.	Fodder lbs.
1893	27.5	11.5	39.0	3040	34.6	10.1	44.7	3212
1894	34.2	5.7	39.9	2755	34.5	6.3	40.8	3325
1895	54.5	1.9	56.4	3241	52.1	1.7	53.8	3125
1896	56.6	2.1	58.7	3050	46.8	2.4	49.2	3226
1897	63.1	3.9	67.0	3540	65.3	3.7	69.0	3068
1898	61.0	3.6	64.6	3909	55.7	3.9	59.6	3764
Average	49.5	4.8	54.2	3256	46.2	4.7	52.2	3286

Note:—All the yields of grain are calculated for 70 lbs. per bushel on the weight of the corn on the ear.

In Deep Cultivation the corn was worked to a depth of six or seven inches, and in Shallow Cultivation only to a depth of two or three inches. The same implement was used in both cases, but was weighted for the deep cultivation.

The results given in the above table show the average to be slightly in favor of the deep cultivation, but the detailed results for the different years divides the favors equally. The rainfall for the growing months, which is given in Table 4, do not contribute anything to explain the reason for these results.

TABLE IV.—RAINFALL FOR THE MONTH IN WHICH CORN WAS GROWING DURING THE SIX YEARS IN WHICH THESE EXPERIMENTS WERE CONDUCTED.

	1893	1894	1895	1896	1897	1898	Average.
May	4.51	3.90	3.16	2.54	7.45	3.49	4.17
June	2.68	1.81	5.50	2.00	3.49	.35	2.63
July	2.74	2.86	2.27	2.23	5.29	2.11	3.08
August ..	1.99	3.56	2.57	1.91	3.02	6.08	3.18
Total	11.92	12.13	13.50	9.68	19.25	12.03	13.06

At the present time there is not so much discussion between Deep and Shallow Cultivation and frequent and unfrequent cultivation as performed in these tests as there is between the old idea to which some people still cling of cultivating corn very deep with the old double shovel plow or a "laying by" with a one-horse plow, in opposition to the method of cultivating corn very frequently all through the season until the ears are well formed with a very light and small rake toothed cultivator, which does not stir the ground more than one-half to one inch deep. This last method, in view of modern studies of root growth and methods for preservation of moisture, should seem to be the most rational to pursue and will form the basis of our future studies upon cultivation.

FREQUENT VERSUS UNFREQUENT CULTIVATION OF CORN.

TABLE V.—YIELD OF CORN AND FODDER PER ACRE FOR SIX CONSECUTIVE YEARS.

Years Tested.	Frequent Cultivation.				Unfrequent Cultivation.			
	Merchantable Grain. Bus.	Unmerchantable Grain. Bus.	Total Yield of Grain. Bus.	Fodder lbs.	Merchantable Grain. Bus.	Unmerchantable Grain. Bus.	Total Yield of Grain. Bus.	Fodder lbs.
1894	33.0	6.5	39.5	3191	35.7	5.4	41.1	2289
1895	47.7	1.6	49.3	3133	52.3	1.5	53.8	3341
1896	44.0	1.8	45.8	2898	43.7	2.3	46.0	2804
1897	66.2	3.6	69.8	3189	56.8	4.1	60.9	2641
1898	61.9	2.3	64.2	3890	60.5	2.8	63.3	3875
Average	50.5	3.2	53.7	3260	49.8	3.2	53.0	2989

In most of these tests the frequent cultivation plot was worked three times and the unfrequent but twice, the middle cultivation being omitted. The same implement was used in both cases. The average results as will be seen gave practically no difference.

PLANTING CORN IN WIDE VERSUS NARROW ROWS.

TABLE VI.—YIELD OF CORN AND FODDER PER ACRE.
Wide rows 5 feet apart, one stalk each; narrow rows 3 feet 9 inches apart, one stalk each 15 inches. For six consecutive years.

Years Tested.	Wide Rows.				Narrow Rows.			
	Merchantable Grain. Bus.	Unmerchantable Grain. Bus.	Total Yield of Grain. Bus.	Fodder lbs.	Merchantable Grain. Bus.	Unmerchantable Grain. Bus.	Total Yield of Grain. Bus.	Fodder lbs.
1893	37.5	9.0	46.5	3786	40.6	10.1	50.7	5443
1894	34.7	4.2	38.9	2280	40.0	5.3	45.3	3485
1895	48.3	1.1	49.4	3006	38.7	1.1	39.8	2588
1896	46.2	2.0	48.2	3370	44.8	1.6	46.4	2851
1897	68.5	1.9	70.4	3514	69.3	2.2	71.5	3607
1898	58.3	1.7	60.0	3362	61.2	2.0	63.2	3862
Average	48.9	3.3	52.2	3219	49.1	2.2	25.8	3639

The average of the results show that there is practically no difference in the two methods pursued, but a comparison of the results of the narrow rows, where the corn was planted 15 inches apart in the row, and the drilled corn in Table VII., where the corn was planted 22½ inches in the row, show the results on the average to be slightly in favor of the thicker seeding, and in one case, that of 1897, to be as much as 21 bushels in its favor.

DRILLED VERSUS CHECKED CORN PLANTING.

TABLE VII.—YIELD OF CORN AND FODDER PER ACRE.

Drilled corn rows 3 feet 9 inches apart, one stalk each 22½ inches; checked hills 3 feet 9 inches; two stalks per hill. For five consecutive years.

Years Tested.	Drilled Corn.				Checked Corn.			
	Merchantable Grain.	Unmerchantable Grain.	Total Yield of Grain.	Fodder	Merchantable Grain.	Unmerchantable Grain.	Total Yield of Grain.	Fodder
	Bus.	Bus	Bus	lbs.	Bus.	Bus	Bus	lbs.
1894	59.3	3.5	62.8	3291	55.9	2.8	58.7	3190
1895	34.8	1.0	35.8	2349	32.3	0.9	33.2	1824
1896	48.6	1.2	49.8	2675	41.6	1.2	42.8	1920
1897	47.9	2.5	50.4	1792	47.2	1.9	49.1	2142
1898	53.8	0.8	54.6	2987	52.9	1.2	54.1	2894
Average	48.9	1.8	50.7	2618	46.0	1.6	47.6	2394

The above results show that each year the results were in favor of the drilled corn over checked row planting, and the experience here was that it was just as easy to keep the drilled corn clean.

POTATO EXPERIMENTS—1897 AND 1898.

The tests made with potatoes during the seasons of 1897 and 1898 were a continuation of those which had been in progress for the three previous years and upon which reports were made in Bulletins Nos. 25, 31, 38 and 46. The following is a list of the experiments conducted in 1897 and 1898:

I. Test of Varieties.

II. Spraying for Blight
- 2. Sprayed vs. not Sprayed.
- 3. Early Spraying vs. late Spraying.

III. Culture Tests......
- 4. Early vs. Late Culture.
- 5. Deep vs. Shallow Culture.
- 6. Ridged vs. Flat Culture.
- 7. Wide vs. Narrow Rows.

VARIETY TESTS IN 1897.

Description of Land and Culture:—The land used in 1897 was the plots north of the phosphoric acid series, which was in a heavy, mixed timothy and clover, sod. This was plowed under December 10, 1896, and again gone over with a double shovel plow on April 3, 1897. Commercial fertilizer was applied in the row at the rate of 700 pounds per acre. It was composed of a mixture of 250 pounds South Carolina rock, 200 pounds dried blood, 100 pounds nitrate of soda, and 150 pounds high-grade sulphate of potash. The potatoes were planted April 20 in rows 2 feet 4 inches apart, and one piece dropped each 16 inches in the row. The land was rubbed down May 8 and cultivated May 26, June 12 and June 17. The potatoes were sprayed with Bordeaux solution and paris green on June 7, June 16 and July 7. The yields of the varieties tested in 1897 are given in Table VIII, in which it will be noticed that Holton Rose were used on every sixth row as a check on the inequalities of the ground. The five varieties giving the highest yields in 1897 were as follows: Holton Rose, 263 bushels; Carman No. 3, 252 bushels; Summit, 243 bushels; Carman No. 1, 232 bushels, and Lee's Favorite, 232 bushels.

TABLE VIII.—VARIETIES OF POTATOES TESTED AND YIELDS PER ACRE (1897.)

Plot No.	Name of Varieties.	Merchantable Bushels.	Unmerchantable Bushels.	Total Bushels.
1	Early Maine	95.0	25.9	120.9
2	New Bovee	127.4	35.6	164.9
3	Acme Seedling	84.3	19.4	103.7
4	Burr's No. 1 Ford	155.6	25.9	181.5
5	Early Harvest	90.7	21.6	112.3
6	Holton Rose	173.9	30.2	204.1
7	Early Cyclone	95.0	25.9	120.9
8	Van Guard	162.0	34.5	196.5
9	Sunlight Star	134.0	30.2	164.2
10	Thorburn	144.6	30.2	174.8
11	Irish Cobler	112.4	19.4	131.8
12	Holton Rose	170.7	30.2	200.9
13	Pearl of Savoy	159.8	23.6	183.5
14	Charles Downing	127.4	12.9	140.4
15	Lightning Express	178.2	12.9	181.2
16	Early Vaughn	125.2	32.3	157.6
17	Early Ohio	71.8	8.6	80.4
18	Holton Rose	164.1	15.1	179.3
19	Early Puritan	159.8	34.5	194.3
20	Early Northern	155.6	30.2	185.8
21	Beauty of Hebron	151.1	21.6	172.7
22	Minister	186.8	32.3	219.2
23	Lee's Favorite	201.9	30.2	232.1
24	Holton Rose	184.7	28.7	213.4
25	Early Fortune	140.2	25.9	166.7
26	Early Michigan	166.3	30.2	196.5
27	Early Thoroughbred	71.2	6.4	77.7
28	Milwaukee	144.6	25.9	170.5
29	Early Rose	121.4	25.9	147.3
30	Holton Rose	187.8	17.3	205.1
31	Garfield	199.8	15.1	214.9
32	Carman No. 1	212.8	19.4	232.2
33	King of Rose	169.8	25.9	195.7
34	Salzer's Earliest	60.5	4.3	64.8
35	Drear's Standard	173.9	12.9	186.8
36	Holton Rose	213.9	30.2	244.1
37	Early Wisconsin	168.5	25.9	194.4
38	Arizona	155.6	38.9	194.5
39	Handen Beauty	210.5	21.6	232.1
40	Tonhocks	162.0	43.2	205.2
41	Wisconsin Beauty	176.0	23.7	199.7
42	Holton Rose	233.4	30.2	263.6
43	Early Market	69.1	10.8	79.9
44	Polaris	114.5	30.2	144.7
45	Early Sunrise	199.8	30.2	230.0
46	New Queen—Home-Grown Seed	178.2	32.3	210.5
47	New Queen—Northern-Grown Seed	199.8	21.6	221.0
48	Holton Rose	178.2	30.2	208.4
49	Summit	204.1	30.2	234.3
50	Lee's Favorite	173.9	36.8	210.6
51	Crown Jewell	195.5	34.5	230.0
52	Carman No. 3	220.4	32.5	252.9

VARIETY TESTS OF POTATOES, 1898.

Description of Land and Culture:—The piece of land used for this test was the north end of the second section east of the pike and south of the station buildings. It is a clay soil, which had been in sod for two years, and from which two crops of mixed clover and timothy hay had been taken. The sod was plowed under January 20. The ground was prepared April 9 and 10, and potatoes planted on the 11th. They were fertilized in the row at the rate of 700 pounds per acre, of a mixture of 250 pounds South Carolina rock, 100 pounds dried fish, 100 pounds nitrate of soda, and 150 pounds high-grade sulphate of potash. The rows were 2 feet 4 inches apart and the potatoes planted one piece to each 16 inches of row. They were cultivated as usual and sprayed with paris green. The potatoes came up well and made a remarkably fine growth for several weeks and gave excellent promise of a good crop, until the weather turned suddenly dry and hot about the middle of May, when the vines almost entirely died in a few days. The Holton Rose were used on the check plots. The details as to varieties tested and yields obtained are given in Table IX.

The five varieties giving the highest yields in 1898 were as follows: Vigerosa, 134 bushels; Early Vaughn, 132 bushels; Bovee, 131 bushels; Holton Rose, 129 bushels, and Early Harvest, 126 bushels.

TABLE IX.—VARIETIES OF POTATOES TESTED AND YIELDS PER ACRE (1898).

	Varieties.	Primes Bus.	Seconds Bus.	Culls Bus	Total Bus
1	Early Michigan	65.0	40.0	18.5	123.5
2	Early Market	57.5	18.3	11.7	87.5
3	Burr's No. 1	60.9	28.3	25.0	114.2
4	Early Harvest	50.8	52.5	23.3	126.6
5	Early Fortune	40.0	53.3	23.3	116.6
6	Arizona	50.8	42.5	30.0	123.3
7	Wisconsin Beauty	50.0	40.8	17.3	122.5
8	Holton Rose	58.3	43.3	27.5	129.1
9	Vigorosa	66.8	39.0	28.3	134.1
10	Signal	50.0	29.2	23.3	102.5
11	New Queen	50.8	47.5	27.5	125.8
12	Early Rose	60.8	40.8	21.7	123.3
13	Polaris	37.7	45.8	27.5	104.0
14	Beauty of Hebron	55.0	28.3	25.0	108.3
15	Triumph	55.0	37.7	20.8	108.3
16	Holton Rose	62.5	28.3	18.3	109.3
17	Ohio Jr.	38.3	35.8	17.3	91.4
18	Early Sunrise	37.7	31.4	23.3	92.4
19	Thorburn	40.0	44.9	28.3	113.2
20	Early Ohio	35.9	18.3	11.7	65.9
21	Acute	38.3	39.0	11.7	89.0
22	Early Vaughn	70.0	44.9	17.3	132.2
23	Heirs Seedling	36.8	31.4	11.7	79.9
24	Holton Rose	59.1	23.3	15.8	112.4
25	Early Northern	59.1	28.3	25.0	112.1
26	King of Earliest	27.5	43.3	18.3	89.1
27	Early Cyclone	28.8	30.0	17.0	78.8
28	Lightning Express	59.1	37.5	21.7	118.3
29	Tonhocks	31.4	55.0	23.3	109.7
30	King of Rose	44.1	31.4	27.5	103.0
31	Lee's Favorite	50.0	25.0	34.0	109.0
32	Holton Rose	58.3	35.8	28.3	122.4
33	Handen Beauty	36.8	37.7	19.2	93.7
34	Crown Jewell	54.0	43.3	17.0	114.3
35	Penn Manor	16.0	27.5	30.0	73.5
36	Maule's Early Thoroughbred	40.0	45.8	23.3	109.1
37	Burpee's Extra Early	53.3	27.5	23.3	104.1
38	Pearl of Savoy	39.0	41.6	17.0	97.6
39	Milwaukee	47.5	24.8	26.6	98.9
40	Holton Rose	36.8	36.8	17.0	90.6
41	Extra Early Vermont	51.7	37.4	17.0	105.1
42	Pride of the South	48.8	24.8	20.8	94.4
43	Pride of the South	45.8	36.8	30.0	112.6
44	Dreer's Standard	60.0	15.8	11.6	87.4
45	Early Puritan	57.5	44.1	21.6	123.2
46	Bovee	43.3	54.0	34.0	131.3
47	Irish Cobler	62.5	40.0	15.0	117.5
48	Holton Rose	44.1	30.0	25.8	99.9
49	Rose No. 25	50.0	37.4	23.3	110.7
50	Early Andes	25.3	32.0	27.0	84.3
51	New Main Crop	36.7	29.0	22.0	87.0
52	Pride of Michigan	23.5	46.9	23.5	93.9
53	Hugh's Seedling	38.0	21.7	19.0	78.7

During the past five years considerable has been done in testing varieties of potatoes, particularly those advertised to be early. Many of them have great claims, made by the originators, which often fail to materialize in actual practice, consequently the farmer should be cautious in spending much on new varieties when they are first introduced. There is a great difference in the value of varieties for different soils and climates, and while the soil at this place is not particularly well adapted to potatoes, yet the results obtained ought to be fairly reliable for most of Maryland.

The following table gives the average results for varieties under test for more than three years and the yield above 150 bushels per acre:

TABLE X.—VARIETIES GIVING AN AVERAGE YIELD OF OVER 150 BUSHELS PER ACRE (1894-1898).

No..	Name of Variety.	No. Years Tested.	Average Yield Bus.
1	Crown Jewell	4	205
2	Holton Rose	3	194
3	Pearl of Savoy	4	174
4	New Queen	5	173
5	Summit	3	170
6	Garfield	3	169
7	Van Guard	3	167
8	Lee's Favorite	3	164
9	Early Rose	4	158
10	Early Harvest	4	156
11	Early Sunrise	3	155
12	Handen Beauty	3	154
13	Arizona	3	153
14	Tonhocks	3	151
15	Early Michigan.	3	150

SPRAYING AND WORKING TESTS IN 1897 AND 1898.

Description of Land and Treatment, 1897:—The land used in these tests in 1897 was the same piece that had been used in the variety potato tests in 1896. After the crop of 1896 was dug, the land was seeded down to crimson clover, which made a remarkably fine growth. This clover was cut for hay on May 17, and the stubble turned under May 31 for the crop of 1897. The potatoes were planted June 21, rubbed down June 28 and cultivated on July 17 and July 31. All plots unless not required by the test, were sprayed on July 20, July 31, August 14 and August 24.

In 1898 these tests were put on a piece of land which had a heavy crop of crimson clover plowed under which had been seeded in the corn crop of 1897 at its last working. The potatoes were planted on July 1 and cultivated on July 12, July 23 and August 22. Early spraying was done on August 1 and 22. Late spraying on August 22 and September 29.

In both 1897 and 1898 the potatoes were fertilized in the row at the rate of 500 pounds per acre of the following mixture: Dissolved South Carolina Rock, 720 pounds; tankage 570 pounds; nitrate of soda 280 pounds; sulphate of potash 430 pounds; total, 2,000 pounds.

The results of these together with those of previous years during which these same tests have been conducted, with the average of the whole, will be found on the following pages.

EARLY VERSUS LATE SPRAYING FOR POTATO BLIGHT.

The experiment was instituted for the purpose of ascertaining how early it is desirable to commence spraying. The early spraying was commenced from ten to fifteen days earlier than the late spraying.

TABLE XI.—YIELD OF POTATOES PER ACRE, EARLY SPRAYED AND LATE SPRAYED.

The average results obtained in these tests show but litttle difference in the two methods.

Years Tested.	Early Sprayed.			Late Sprayed.		
	Merchantable Bus.	Unmerchantable Bus.	Total Bus.	Merchantable Bus.	Unmerchantable Bus.	Total Bus.
1893	.....	.....	90.6	.....	.....	83.9
1894	94.4	28.2	122.6	78.1	19.9	98.0
1895	147.6	14.8	162.4	156.7	17.8	174.5
1896	101.5	8.2	109.7	140.2	3.5	143.7
Average	114.5	17.1	121.3	125.0	13.7	125.0

SPRAYED VERSUS NOT SPRAYED FOR THE PREVENTION OF BLIGHT.

The object of this test was to prevent the leaf blight of the potato which is so prevalent in all sections of this State. The solution used for the purpose was well known Bordeaux mixture, which was made up of six pounds of copper sulphate (Blue stone), six pounds of good, fresh stone lime and fifty gallons of water. The rule was to give three applications to each crop.

TABLE XII.—YIELD OF POTATOES PER ACRE SPRAYED AND NOT SPRAYED.

Years Tested.	Sprayed.			Unsprayed		
	Merchantable Bus.	Unmerchantable Bus.	Total Bus.	Merchantable Bus.	Unmerchantable Bus.	Total Bus.
1893	.....	.....	81.1	.....	.....	61.9
1894	85.9	14.7	100.6	61.9	14.5	76.4
1895	68.8	15.4	84.2	31.7	13.5	45.2
1897	140.0	18.3	158.3	121.1	18.8	139.9
1898	100.2	5.9	106.1	74.2	4.7	78.9
Average	98.7	13.6	106.1	72.2	12.9	80.5

It will be noticed from the above results that there was always a decided advantage in spraying, and one point particularly prominent, that the greatest relative difference occurred in the unfavorable years or when the yeilds were low.

EARLY VERSUS LATE CULTIVATION OF POTATOES.

In this test the plot receiving late cultivation received one more working than the other, which was generally given about ten days after the other had been laid by.

TABLE XIII.—YIELD PER ACRE FROM EARLY AND LATE CULTIVATIONS.

Years Tested.	Early Cultivation.			Late Cultivation.		
	Merchantable. Bus.	Unmerchantable Bus.	Total Bus.	Merchantable Bus	Unmerchantable Bus.	Total Bus.
1894	96.6	18.0	114.6	96.5	20.0	116.5
1895	78.1	13.1	91.2	68.4	13.6	82.0
1896	78.9	15.4	94.3	78.9	11.4	89.3
1897	130.8	16.0	146.8	140.5	19.0	159.5
1898	105.8	9.4	115.2	90.6	7.0	97.6
Average	98.0	14.4	112.4	95.0	14.0	109.0

The average of the results with early and late cultivation give practically no difference in the two methods pursued.

DEEP VERSUS SHALLOW CULTIVATION OF POTATOES.

The implement used in these tests was the same for each plot, but in the shallow cultivation it was set so as not to go more than two to two and one-half inches deep, while in the deep cultivation the cultivation was regulated so as to run five or six inches deep.

TABLE XIV.—YIELD PER ACRE FROM DEEP AND SHALLOW CULTIVATION.

Years Tested.	Deep Cultivation.			Shallow Cultivation.		
	Merchantable Bus.	Unmerchantable Bus.	Total Bus.	Merchantable Bus.	Unmerchantable Bus.	Total Bus.
1894	72.0	18.1	90.1	67.7	20.9	88.6
1895	85.2	15.9	101.1	87.0	15.1	102.1
1896	125.0	12.3	137.3	130.7	9.5	140.2
1897	151.2	17.3	168.5	138.4	14.8	153.2
1898	89.4	10.0	99.4	84.8	6.7	91.5
Average	104.7	14.7	121.1	101.7	13.4	115.1

From the above we see that the average result is slightly in favor of the deep cultivation.

RIDGED VERSUS FLAT CULTURE OF POTATOES.

In this test all the cultivations of both plots were just the same, except the last working of ridge culture, which was given by means of a single shovel plow with broad shovel attached, which threw the earth up in a ridge next to the vines, leaving a hollow in the center of the row. The other plot was cultivated with an ordinary cultivator and left flat at the last working.

TABLE XV.—YIELD PER ACRE FROM RIDGE AND FLAT CULTURE.

Years Tested.	Ridge Culture.			Flat Culture.		
	Merchantable Bus.	Unmerchantable Bus.	Total Bus.	Merchantable Bus.	Unmerchantable Bus.	Total Bus.
1893	71.7	24.1	95.8	72.8	21.3	94.1
1894	77.8	17.9	95.7	69.6	21.7	91.3
1895	64.7	14.6	79.3	73.1	8.7	81.8
1896	92.2	13.9	106.2	85.0	12.3	97.3
1897	144.5	17.8	162.3	154.7	18.3	173.0
1898	77.5	7.0	84.5	93.0	8.2	101.2
Average	88.1	15.9	104.0	91.4	15.1	106.4

From the above table it will be seen that the average results of six years test showed practically no difference between the two methods pursued.

PLANTING POTATOES IN WIDE VERSUS NARROW ROWS.

The wide rows were three feet apart and one piece of potato seed dropped each 12 inches in the row. The narrow rows were used of two widths—2¼ feet apart and 14 inches in the row, and 2¼ feet apart and 16 inches in the row. The latter distance was used in 1897 and 1898. The treatment for both plots was the same in all other respects.

TABLE XVI.—YIELD PER ACRE FROM WIDE AND NARROW ROWS.

Years Tested.	Wide Rows.			Narrow Rows.		
	Merchantable Bus.	Unmerchantable Bus.	Total Bus.	Merchantable Bus.	Unmerchantable Bus.	Total Bus.
1894	67.1	17.9	85.0	86.0	21.0	107.0
1895	67.5	8.9	76.4	79.5	12.8	92.3
1896	63.3	11.3	74.6	89.3	12.9	102.2
1897	143.0	19.0	162.0	150.0	21.5	171.5
1898	91.4	7.0	98.4	70.8	7.8	78.6
Average	86.5	12.8	99.3	95.1	15.2	110.3

The above results show an average difference in favor of the narrow rows. This difference is commonly believed to be due to the greater covering to the ground by the vines in the narrow rows, which causes a preservation of moisture.

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